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RELATIONSHIP BETWEEN HAND GRIP STRENGTH AND PHYSICAL ACTIVITY, NUTRITION AND BODY COMPOSITION IN HEALTHY PEOPLE VS. UNHEALTHY PEOPLE

Dissertação elaborada com vista à obtenção ao grau de Mestre na Especialidade de Exercício e Saúde

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RESUMO

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A perda de massa isenta de gordura (MIG) e a força muscular estão intimamente relacionadas, e estão associados com o envelhecimento. Estas reduções devem ser devidas a algumas das mais importantes razões para a diminuição da força muscular na população idosa, o qual se associa com "impairment" funcional. Estas perdas de MIG e força muscular são denominadas sarcopenia. Normalmente a perca de força de pressão manual (PM) é maior que as percas de massa muscular no envelhecimento; embora as doenças e a obesidade tem sido factores que influencia a perda de força, a sua associação com outros factores do estilo de vida tem sido pouco estudada. O objetivo deste estudo foi analisar as relações entre os determinantes clássicos de força, nutrição, actividade física (AF) e FM. Adicionalmente, comparar estes mesmos parâmetros entre grupos sem (GS) e com doenças (GNS), e com obesidade sarcopénica (GOS) e sem obesidade sarcopénica (GSOS). Também foram analisados os determinantes da FM. **Métodos**: Um total de 103 sujeitos (61.16±7.74 anos; 70.43±12.33 kg) participaram neste estudo transversal. A composição corporal foi avaliada com bioimpedância tetrapolar. Actividade física e ingestão nutricional foram estimadas com questionários. A FM foi avaliada usando dinamômetro manual. As associações entre variáveis foram avaliadas usando coeficientes de correlação Pearson e Spearman; as diferenças entre grupos foram analisadas utilizando Test-t para amostras independentes e/ou test de Mann-Whitney e procedimento regressão linear (stepwise) múltipla foram usados para estimar os determinantes da FM.

Resultados: O GS teve correlações positivas entre FM y AF (r = 0.286; $P< 0.05$), a ingestão total de proteína em gramas (r = 0.543; $P< 0.01$), a MIG (r = 0.852; $P< 0.005$), e o índice de massa isenta de gordura (IMIG) (0.748; $P< 0.05$). Adicionalmente, correlações negativas ajustadas pela idade foram encontradas entre actividades da casa e FM no grupo de OG (r = -0.391; $P < 0.05$) e no GSOS (r = -0.383; $P < 0.01$). Finalmente o principal predictor da FM foi a MIG, que explicou o 68.8% da variabilidade da FM.

Conclusões: Os nossos resultados sugerem que elevados níveis de MIG e a ingestão total de proteína em gramas e baixos níveis de massa gorda e actividade de casa são os maiores determinantes de FM em GS e GNS da população idosa ainda quando ajustamos para a idade.

Palavras-chave: força, massa isenta de gordura, ingestão de proteína, sarcopenia, obesidade sarcopénica, obesidade, massa muscular, força muscular, população idosa, composição corporal, actividade física.

ABSTRACT

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Losses of fat free mass (FFM) and muscular strength are closely related, and they are commonly associated with aging process. These reductions must be some of the most important reasons for muscular strength in elderly people, which associated with functional impairment. These FFM losses and muscular strength reduction are denominated sarcopenia. Loss of strength is greater than losses of muscle mass with aging, although disease state and obesity must play a role in this sarcopenic syndrome. It was our aim to analyze the relationship between the classical determinants of strength, such as nutrition, physical activity (PA) and body composition, and hand grip strength (HGS) in older people, additionally compare these parameters between groups with and without disease, healthy group and unhealthy group (HG vs. UHG) or sarcopenic obesity group and non sarcopenic obesity group (SOG vs. NSOG). We also explored determinants of HGS. **Methods**: A total of 103 subjects (61.16±7.74 years; 70.43±12.33 kg) participated in this transversal study. Body composition was assessed by tetrapolar bioimpedance. Physical activity and nutrition were estimated using questionnaires. Strength was assessed using digital hand grip dynamometer. Pearson's and Spearman's coefficients of correlation were used to analyze the relationship between variables. Independent sample T-test and Mann-Whitney's non-parametric test were utilized to compare differences between groups. Finally, stepwise linear regression was carried in order to estimate the main determinants of handgrip strength.

Results: HG had positive correlation between HGS and activity score (r = 0.286; $P<$ 0.05), total grams of protein intake (r = 0.543; $P<$ 0.01), fat free mass (FFM) (r = 0.852; $P<$ 0.005), fat free mass index (FFMI) (0.748; P 0.0). Negative correlation were found adjusting for age between score house and HGS in SOG (r = -0.391; $P < 0.05$) and in NSOG (r = -0.383; $P <$ 0.01). The main predictor of HGS was FFM, which explain 68.8% of HGS variability.

In conclusion, these results suggest that high levels FFM and total grams of protein and low percentage of FM and low score of household physical activities are the major determinant of HGS in HG and UHG elderly people even adjusted for age.

Keywords: strength, fat free mass, protein intake, sarcopenia, sarcopenic obesity, muscle mass, muscle strength, elderly people, body composition, physical activity.

Abbreviations List

%_fat: percentage of fat

%_hc: percentage of carbohydrates

%_prot: percentage of protein intake

%FM: percentage of fat mass

AC: arm circumference

AMA: corrected arm muscle area

ASM: apendicular skeletal muscle mass

BMI: body mass index

CSA: cross sectional area

CT: X-ray computed tomography

DBP: diastolic blood pressure

DEXA: dual X-ray absorptiometry

FFM: fat free mass

FFMI: fat free mass index

FM: fat mass

FMI: fat mass index

g_prot: total grams of protein intake

HG: healthy group

HGS: hand grip strength

HGSA: hand grip strength corrected by arm area

HR: heart rate

MRI: magnetic resonance imaging

MS: muscular strength

MU: motor unit

NSOG: non sarcopenic obese group

PA: physical activity

PAQ-O: physical activity questionnaire for elderly people

Prot_I_kg: grams protein intake per kg of body weight

Prot_I_kgFFM: grams protein intake per kg of fat free mass

SBP: systolic blood pressure

SD: standard deviation

SMM: skeletal muscle mass

SO: sarcopenic obesity

SOG: sarcopenic obese group

TDEI: total daily energy intake

UHG: unhealthy group

WC: waist circumference

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1. INTRODUCTION

Skeletal muscle mass (SMM) loss and function related with aging process represent an important public health issue, which affects mainly older people. This combination of reduced SM and strength is known as sarcopenia. SM tissue accounts for almost half of the human body mass and is a main factor in maintaining metabolic homeostasis (i.e. glucose homeostasis), muscle strength and functionality. Moreover, loss of mobility due to age-related SM deterioration is one of the primary determinants of the need for nursing home care and dependence. It has been estimated that sarcopenia costs the United States over $18 billion per year in healthcare expenses (Janssen I, Shepard DS, 2004), which could be partially reduced with lifestyle interventions. Additionally, another modifiable health risk factors as obesity have been suggested to exacerbate sarcopenia, so older sarcopenic patients could accumulate excess of adiposity independently of losing SM, which has been defined as sarcopenic obesity condition.

In this previous framework the implementation of new exercise and nutrition intervention must be a cornerstone to improve the quality of life, health and independence of elderly population. However, several mechanism and associations between SM, physical activity (PA), nutrition and disease, and strength need to be more studied. The work presented in this manuscript explores the associations between muscle strength, protein intake and PA in a sample of older adults with and without disease. Furthermore, we have tried to analyze if older adults classified as sarcopenic obese had different characteristics in strength, nutritional variables or PA in comparison with non sarcopenic obese adults.

2. BACKGROUND

Losses of fat free mass (FFM) and muscular strength (MS) are closely related, and they are commonly associated with the aging process (Flynn, Nolph, Baker, Martin, & Krause, 1989; Going, Williams, & Lohman, 1995). These reductions must be some of the most important reasons for muscular dysfunctions (lower muscle efficiency to develop muscular tension) in elderly people, which have been associated with functional impairment (difficulty to perform daily physical activities) (Morley, et al., 2011), diseases (Conroy, et al., 2012; Park, et al., 2009; Park, et al., 2006) and even mortality (Newman, et al., 2006). These FFM losses and MS reduction, which may happen during senescence, are denominated sarcopenia (from the Greek roots sarx (flesh) and penia (loss) (Newman, Kupelian, et al., 2003; Rosenberg, 1989). Sarcopenia occurs with normal aging, and it must happen at an accelerated rate in catabolic illnesses even with minimal or no weight loss (cachexia) and most rapidly of all during unintentional weight loss (wasting). Muscle strength and power decline more than muscle dimensions (Narici, et Maffulli, 2007). The term coined by Rosenberg, which is widely used to describe SM loss, is often used to describe both a set of cellular processes (denervation, mitochondrial dysfunction, inflammatory and hormonal changes) and a set of outcomes such as decreased muscle strength, decreased mobility and function, increased fatigue, increased risk of metabolic disorders, and increased risk of falls and skeletal fractures. Since, it may responsible for a high percentage of cases of muscular disability (Roubenoff, 2000), sarcopenia has become a major concern for public health and research from the last decades (Cesari, et al., 2012).

There is not unanimous functional definition of sarcopenia, however the most common has been proposed by Janssen et al. (2002) in a cross-sectional survey with 4504 adults aged 60 and older and is based on a SM mass index obtain by dividing apendicular skeletal muscle mass (ASM), evaluated by dual X-ray absortiometry (DEXA), by body height squared (ASM/ht^2). According to this definition, individuals presenting an ASM/ht^2 ratio between -1 and -2 standard desviations (SD) of the gender-specific mean value of young controls, are categorized as having

class I sarcopenia. Instead, individuals with an ASM/ ht^2 ratio below -2 SD are categorized as having class II sarcopenia. However, this definition did not include functional factor in the definition, which must be the clinical consequence of low functionality and maybe avoid a misclassification of sarcopenia. Recently a Report of the European Working Group on Sarcopenia in Older People have proposed additional definitions where the functional capacity and strength have been included in the definition (Cruz-Jentoft AJ, et col. 2010). However, a compose of both criteria have not been validated, which may indicate the relationship between strength, SM and functionality it is not always linear, and more factors might be involved in this relationship (Figure 1).

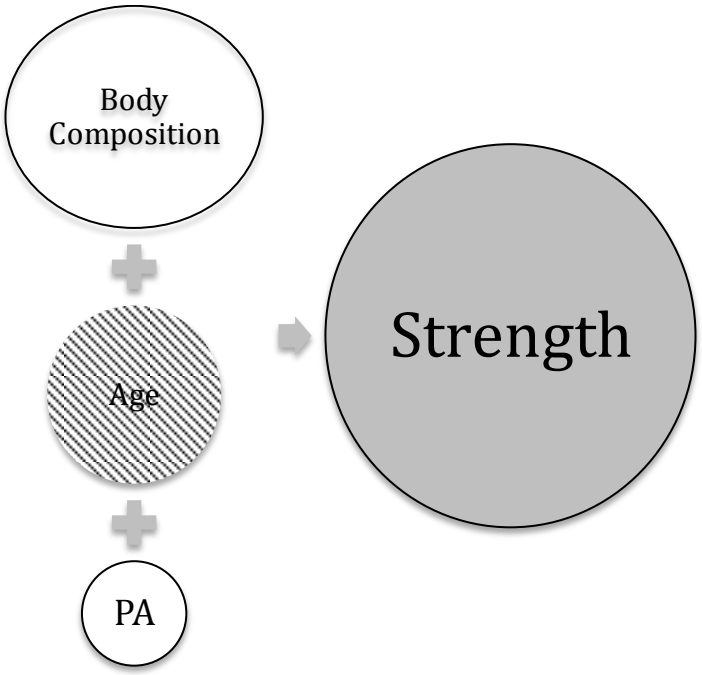

Figure 1. Theoretical determinants of strength. PA, physical activity.

Although, low strength on older people may be due to loss muscle mass, however low muscle strength has been proven to be an independent predictor of functional capacity, institutionalization and mortality (Visser, et al., 2005; Rantanen, et al., 2000), and some studies have showed that the loss of strength is greater than loss of muscle mass with aging

(Vandervoort, et al., 1986; Metter, et al., 1999). Additionally, age and body fat had significant inverse associations with strength and muscle quality (Newman, et al., 2003). So, longitudinal studies have shown that fat mass (FM) increases with age and is higher among later birth cohorts peaking at about age 60-75 years (Rissanen, et al., 1988; Ding, et al., 2007), whereas SMM and strength starts to decline progressively around the age of 30 years with a more accelerated loss after the age of 60 (Rantanen, et al., 1998; Frontera, et al., 2000). Visceral fat and intramuscular fat tend to increase, while subcutaneous fat in other regions of the body declines (Beaufrère, B., Morio, 2000; Horber FF, Gruber B, Thomi F, Jensen EX, 1997). With this scenario, the loss of SM mass and the gain of body fat with aging may potentiate each other, maximizing their effects on functional limitation in older persons an increased FM may be more predictive of self-reported disability, functional limitation, and poor physical performances than a decreased SM alone (Zamboni M, Turcato E, Santana H, 1999). This may put importance in whole body composition as playing a role as a main determinant of MS and functionality (figure 2). This may confirm results from different studies indicate that sarcopenia is only an important predictor of poor physical function after consideration of the body weight or FM of the individual (Cristini, Kan, Janssen, Morley, & Rolland, 2009; GL, 2005; Jensen GL, 2002; Zamboni M, Turcato E, Santana H, 1999).

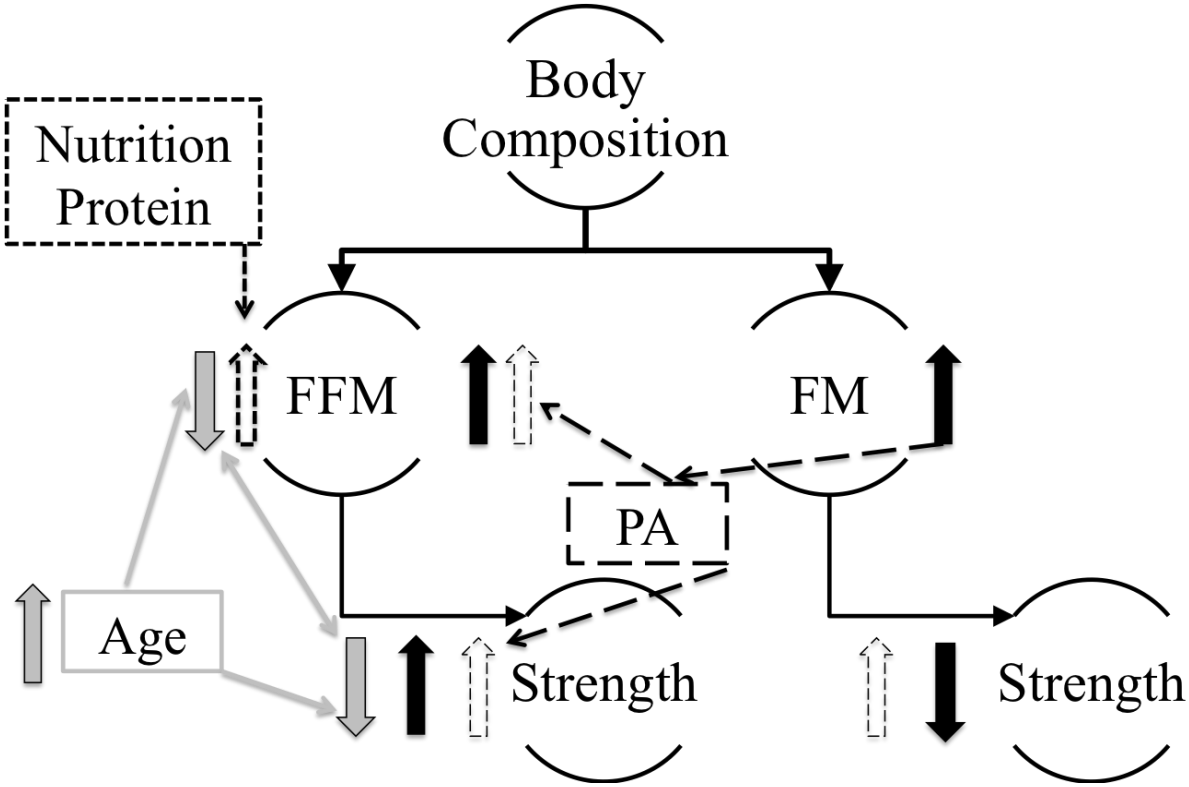

Figure 2. Paradigm of theoretical mechanism of body composition influence on strength. FFM, fat free mass; FM, fat mass; PA, physical activity.

Black thick lines represent genetic and/or unknown influence of body composition variables on strength (flowchart stream). Dashed thick lines represent the influence of interaction between PA and body composition variables on strength (thin dashed lines connect the levels of interaction and plausible mechanism). Grey thick lines represent the influence of interaction between age and body composition variables on strength (thin grey lines connect the levels of interaction and plausible mechanism). Dashed box and arrow shows positive influence of nutrition on strength mediated by FFM increase.

Classical studies have been focused on mechanisms, epidemiology and efficacy of interventions for explaining strength and SMM loss with aging process. The classical studies from USA as The Framingham Heart Study beginning in 1948; The Baltimore Longitudinal Study of Aging (BLS), which start in 1957 (Ferrucci, 2008; Stone & Norris, 1966); the Harvard Alumni Health Study, a prospective cohort study, where alumni of University of Harvard were observed between 1962 and 1988, have highlighted important issues related with exercise and longevity (I. M. Lee, Hsieh, & Paffenbarger, 1995). More recently, surveys have been focused specifically in body composition area and strength, so between 1997 and 1998 was carried out

the baseline of The Health, Aging and Body Composition Study (Health ABC study), which included a specific section aimed to elucidated associated variables with sarcopenia, so FFM, SSM and MS were analyzed in relationship with PA and nutrition (Goodpaster, et al., 2001; Newman, Haggerty, et al., 2003). In the 21st century new studies have been focusing in different aspects related with sarcopenia, hence the elderly EXERNET Spanish multicenter study is collecting data of sarcopenia and sarcopenic obesity prevalence, and related factors (Gomez-Cabello, et al., 2011).

FFM, SM and Body Composition Influence

FFM is a complex body composition compartment, which include water, bone mineral and muscular protein. All these compartments are reduced naturally from 40 years old. However, it is well known that they do not contribute equally to strength production. The tissue-organs level must be a better-fitted approach than molecular level to study the relationship between body composition and exercise performance, since the assessment of quantitative and qualitative of SMM characteristics should be more related with exercise performance than FFM. Nowadays, there is evidence that some types of muscle are associated with diseases and hospitalization risk (Cawthon, et al., 2009), and low exercise capacity and strength (Goodpaster, et al., 2001). For in instance, low-density muscle as assessed by computed tomography (CT) has been described in older type II diabetes patients (Goodpaster, et al., 2008); expanded intermuscular and intramuscular adipose tissue assessed by magnetic resonance imaging (MRI) has been also related with several metabolic disorders (Manini, et al., 2007), poor aerobic capacity and strength production (Visser, et al., 2002). So, imaging techniques offer us the possibility to estimate muscle volume (CT and MRI), muscular density (CT) and muscular architecture (ultrasound) (Thom, Morse, Birch, & Narici, 2005). In summary, all these techniques have offered us the possibility to analyze the effect of exercise training/ regular PA and strength/functional capacity. Nevertheless, these previous studies have been concerned mainly with muscle infiltration and maximal strength, and the multicomponent approach of

body composition have not widely explored as related with functional capacity and/or explosive strength manifestations (power, rate of force development or rapid movements). Moreover, imaging methods are expensive and time-consuming, and most of the times unviable in field settings. Bioelectrical impedance (BIA) has been validated to assess accurately distribution of fluids *in vivo* in older humans (Aleman-Mateo, et al., 2010; Schoeller & Kushner, 1989). Also, anthropometric models to estimate SM have been validated, and offer the possibility to assess whole and regional SM (Heymsfield, et al. 1982), which permits us to assess SM in multiple settings.

The relationships between exercise performance, losses of FFM and/or SM components and imbalanced nutrition are not completely elucidated during senescence. Moreover, the effect of exercise training and nutrition intervention on this previous relationship is not completely well understood, and it has been proposed as a new research area of body composition study, which was recently designated as functional body composition (Sardinha, 2012). Taking together organ-tissue, cellular and molecular levels of body composition can be used to develop a better approach to understand possible mechanism related with impaired functional capacity and reduced explosive MS. Specifically, intracellular and/or muscle hydration in athletes and young subjects has been recently suggested as a mechanism of impairment of rate force development and power (Silva, A. M., Fields, D. A., Heymsfield, S. B., & Sardinha, 2010, 2011; Silva, A.M., Matias, C.N., Santos, D.A., Rocha, P.M., Minderico, C.S., Sardinha, 2014). Since water losses are inherent to aging process, it can be a rational argument that interventions focused on preserve total body water and intracellular fluids would promote a positive effect on strength (mainly power and explosive). BIA can be used to provide functional body composition mechanisms related with FFM/SM changes after exercise training programs with elders. Additionally, anthropometry offers the possibility to assess regional SM and so a better explanation of low strength performance in specific test (for in instance handgrip strength test and arm muscle area).

Nutrition

Nutrition is another explicative mechanism related with SM loss. So, a poor nutritional status has been reported in longitudinal observations in elders (Flynn, Nolph, Baker, & Krause, 1992). Accordingly, nutrition has been widely associated with changes of FFM and SM, so elders with higher protein intake and positive energy balances could maintain their FFM (Houston, et al., 2008); also, low micronutrient consumption was related with mobility limitation and disability (Houston, et al., 2013). In addition to inadequate nutrient intake, reduced PA is known to increase the risk of developing sarcopenia (Smith, 2014). Also, a vegetarian diet was associated with a lower SMM index than an omnivorous diet at the same protein intake (Aubertin-Leheudre, et Adlercreutz, 2009). However, reduction of protein intake was not always observed when large samples of older adults were followed over decades (Hallfrisch, Muller, Drinkwater, Tobin, & Andres, 1990), so reduced protein intake must not be the main reason for FFM reduction on elderly population in epidemiological studies. Nevertheless, most of the times a reduced daily energy intake, which is prescribed in order to reduce the excess of FM, can promote non-desirable consequences as reduction of SM, so a combined strategy of exercise training and balanced diet must be an optimized solution (Chomentowski, et al., 2009).

Exercise training and sedentary time

Exercise training and PA have strong anabolic (Chomentowski, et al., 2009; Harber, et al., 2012; Wroblewski, Amati, Smiley, Goodpaster, & Wright, 2011) and functional (Simonsick, et al., 2001) effects in older people, which can promote an increase or maintenance of SM, mainly among who practice exercises with additional resistances (Figueroa, et al., 2003; Figueroa, Park, Seo, Sanchez-Gonzalez, & Baek, 2011; Hurley, Hanson, & Sheaff, 2011; Mero, et al., 2013). Hence it has been hypothesized that elderly people involved in exercise training can maintain their SM or FFM better than others sedentary or with a low level of PA. However, maintenance of SM or FFM does not ensure completely fatigue attenuation (Katsiaras, et al., 2005), strength preservation (Delmonico, et al., 2009; Goodpaster, et al., 2001), or functional

capacity (Ko, Stenholm, Metter, & Ferrucci, 2012). So, it seems that some FFM components and characteristics of SM must be more important than FFM or SM alone (Delmonico, et al., 2009).

Sedentary life-style must be an important risk factor for weight gain (LaMonte MJ, 2006). Obese persons also tend to be less physically active and this may contribute to decreased muscle strength (Duvigneaud N, Matton L, Wijndaele K, 2008). Reduced PA levels described on elderly subjects have been proposed as one of the most important reasons of sarcopenia (Roubenoff, 2000; Talbot, Morrell, Fleg, & Metter, 2007), attenuate fatty acid oxidation in the muscle creating adipose tissue accumulation (Manini, et al., 2007) and its associated-strength loss and mobility (Misner, Massey, Bemben, Going, & Patrick, 1992), which can trade other disabilities (Conroy, et al., 2012; Roubenoff, 2008). Finally, muscle atrophy leads to reduction in metabolic rate both at rest and during PA and may further aggravate the sedentary state, all of which can cause increased adiposity and more SM loss.

Sarcopenic Obesity

Research has previously focused separately on the roles of obesity and sarcopenia in physical functioning and disability. As induced from figure 2, the concurrence of sarcopenia and obesity, which is known as Sarcopenic-Obesity (SO), has been reported to be a much more pejorative condition of the development of physical disabilities than either sarcopenia or obesity alone (Baumgartner RN, Wayne SJ, Waters DL & Gallagher D, 2004). Previous studies have shown the relationships between obesity, sarcopenia and SO, although there are not much studies, which examine the association between sarcopenic-obesity and physical function among older persons.

A cross-sectional evaluation examined the relationship between FFM and physical functioning in three groups of older adults: obese, non-obese frail, and non-obese non-frail (Villareal DT, Banks M, Siener C, Sinacore DR, 2004). The results revealed that the average FFM in the lower extremities of the obese group was significantly higher (8.5 ± 4.0 kg; mean ± SD) compared to their non-obese frail (7.0 ± 2.5 kg) and nonobese non-frail (6.5 ± 2.0 kg)

counterparts (Villareal DT, Banks M, Siener C, Sinacore DR, 2004). Despite having a higher absolute quantity of FFM, the percentage of body weight as FFM and muscle quality (force per unit of cross-sectional muscle area) was lower in the obese adults (Villareal DT, Banks M, Siener C, Sinacore DR, 2004). Furthermore, the obese group had scores that were equal to or lower than those of the non-obese nonfrail group in the physical performance test, peak aerobic power, and the functional status questionnaire. Similar impairments were seen in strength, walking speed, balance, and health-related quality of life (Villareal DT, Banks M, Siener C, Sinacore DR, 2004). Overweight older adults (BMI 25–30 kg/m^2) are thought to be protected from disability as a lower body mass index is often associated with disability (Al Snih S, Ottenbacher KJ, Markides KS, Kuo YF & JS., 2004).

Another observational survey, with 36 women with SO, obesity was associated with having difficulty with physical function either on its own or in the presence of sarcopenia, but sarcopenia was only associated with having difficulty with physical function in the presence of obesity but sarcopenia was not associated with difficulty in physical function in the nonobese but tended to add difficulties in the obese (Cristini et al., 2009). So, this evidence suggest that higher amounts of body fat are more associated with poor physical performance, functional limitation, and subsequent disability than is low SMM (GL, 2005; Jensen GL, 2002; Zamboni M, Turcato E, Santana H, 1999) where excess accumulation of fatty acids around the muscle fibers may interfere with their functioning (Corcoran MP, Lamon-Fava S, 2007). There are only few studies about the combined effect of obesity and muscle impairment where muscle impairment was defined by poor muscle strength. In the cross-sectional Finnish Health 2000 Survey, persons with combination of increased fat percentage and decreased muscle strength had higher prevalence of walking limitation compared to those with only high fat percentage or low muscle strength (Stenholm, et al., 2008).

Finally, Baumgartner et al. (Baumgartner RN, Wayne SJ, Waters DL & Gallagher D, 2004) reported that men with sarcopenic obesity had an odds ratio of 8.72 for two or more self-reported physical disabilities with Instrumental Activities of Daily Living, compared to 3.78 for sarcopenia and 1.34 for obesity and sarcopenic obese women had corresponding odds ratios of

11.98, 2.96, and 2.15, respectively (Baumgartner RN, Wayne SJ, Waters DL & Gallagher D, 2004). These results were confirmed in two later studies, where weight loss intervention combining diet and exercise among older obese people improves muscle strength and muscle quality in addition to fat loss confirming the hypothesis about tight connection between adiposity and impaired muscle function (Frimel TN, Sinacore DR, 2008; Wang X, Miller GD, Messier SP, 2007).

These findings suggest that older adults with SO have more physical frailty than older adults who suffer only of sarcopenia or obesity.

The analysis of the literature demonstrated that obese older adults exhibit physical frailty and underscore the need for an intervention to improve physical function in this population. It is reasonable to hypothesize that low muscle strength and obesity may be pathophysiologically connected which makes them more likely to be associated than expected by chance alone (figure 3).

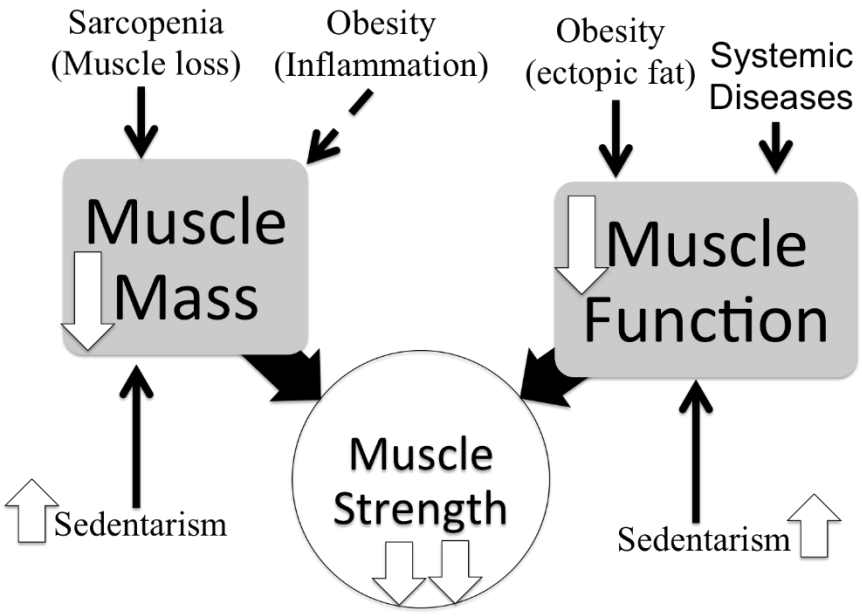

Figure 3. Theoretical connection between disease and muscle strength.

Prospective cohort studies have analyzed the association of age-related loss of muscle strength and mass with adverse clinical outcomes in the older adults, including several disease or impairment conditions (Moreland JD, Richardson JA, Goldsmith CH, 2004; Nevitt MC, Cummings SR, Kidd S, 1989; Visser M, Kritchevsky S, Goodpaster B, Newman A & Stamm E, 2002). However, there is a lack of studies where the influence of disease on strength has been analyzed in relationship with PA, nutrition and body composition. Additionally, studies covering the topic of SO and these latter variables in older people are scant in the literature.

2.1. General Objectives:

- To analyze the associations between variables of nutrition, body composition and PA with hand grip strength (HGS) variables in healthy and unhealthy groups.
- To analyze the differences on body composition, PA, nutrition and HGS between sarcopenic obese participants and non sarcopenic obese participants.
- To explore the main determinants of HGS in our sample of older adults.

3. METHODS

3.1. Study Design.

This is a cross-sectional, descriptive, comparative and correlational study. It consisted in identifying the relationship between the classical determinants of strength, such as nutrition, PA and body composition, and HGS in older people.

All procedures were performed during the same day and lasted 1-hour approximately. Body composition was the first assessment, then strength and the last ones were the questionnaires. Additionally, they brought the list of medicines that they were taking. The Helsinki declaration procedures for human being studies were followed in all procedures (Kong & West, 2008).

3.2. Sample.

Our sample included 103 participants older than 50 years old, with or without chronic diseases, who take or do not take any medications that can influence fluid distribution (in instance, diuretics). They were 48 males and 55 females between 50 and 84 years-old, either sedentary or active.

The tests were carried out in the Exercise and Health Laboratory of Faculty of Human Kinetics, Mega Craque Health Club in Lisbon and Aquazul Health Club in Córdoba.

The inclusion criteria in order to participate in the study were to be at least 50 years old, be able to perform physical fitness tests and have intellectual capacity to describe their PA and nutritional habits. Before doing the assessments and filling out the questionnaire, the objective and procedure of the study was explained to each participant and an informed consent was obtained.

3.3. Questionnaires.

3.3.1 Physical Activity Questionnaire.

The questionnaires were filled out at the same place where the tests were done. After handing out the questionnaires, a detailed explanation was given in order to fill the questionnaires out correctly and by this obtain reliable, valid answers and one-hundred percent of compliance, on average it took twenty minutes to conclude all procedure.

The Physical Activity Questionnaire for the elderly people (Laura E. Voorrips, Anita C.J. Ravelli, Petra C.A. Dongelmans, 1991), annex 1)) was used to measure the level of PA, using 3 different categories: household activities, sport activities and leisure time activities. In the questionnaire, the participants were asked to report their habitual physical activities during the last year. Items on household activities were questions with four to five possible ratting, ranging from every active to inactive. For sports and leisure activities were asked the type of activity, hours per week spent on it, and period of the year in which the activity is usually performed. All activities were classified according to work posture and movements. An intensity code based on net energetic costs of activities, was used to classify each activity (Bink, B., F.H. Bonjer, 1966). Equations to obtain the final score were:

Questionnaire score= household score+ sport score+ leisure time activity score. *Equation 4*

$$\textbf{\textit{Household score}} = (Q1+Q2+\ldots+Q10)/10 \qquad \textit{Equation 5}$$

$$\boldsymbol{Sport - score} = \sum_{I=1}^{2}(ia * ib * ic) \qquad \textit{Equation 6}$$

$$\boldsymbol{Leisure\ time\ activity\ score} = \sum_{J=1}^{6}(ja * jb * jc) \qquad \textit{Equation 7}$$

Where Q was question, ia was intensity of sport (code), ib was hours per week of sport (code), ic was period of the year of sport (code), ja was intensity of leisure time (code), jb was hours per week of leisure time (code) and jc was period of the year of leisure time (code).

3.3.2 Nutritional questionnaire (protein intake).

Nutrition was assessed using the classical food records, where all macro and some micronutrients were obtained from specific software adapted to nutritional behavior of Spain and Portugal citizenships. The Portuguese intakes were calculated by nutritional frequency questionnaire of the Nutritional Epidemiology Department from the Faculty of Medicine of Porto, in annex 3, using website http://higiene.med.up.pt/freq.php. Nutritional frequency questionnaire from the Epidemiology and public Health Department from the University of Navarra, annex 4, was used for Spanish subjects. Both questionnaires were previously validated (Martin-Moreno et al., 1993).

Participants were provided with a food scale and instructed on how to complete the questionnaire. In summary, they needed to report frequency of pattern intake during the last 6-month for common serving sizes of food per month, week or day.

Nutritional questionnaires gave us percentage of protein intake (%_prot). We calculated total grams of protein intake (g_prot), grams of protein intake per kg of body weight (Prot_I_kg) and grams of protein intake per kg of fat free mass (Prot_I_kgFFM).

3.3.3 Health Questionnaire.

An *ad hoc* previously designed health questionnaire, in annex 1, was used to know whether subjects suffer from some chronic disease, such as diabetes, heart disease, pulmonary disease or metabolic disease. Joint injury was measured using a scale from no pain to limit pain. The questionnaire asked also about medication.

Participants were categorized as healthy when without any disease, or unhealthy, who suffer from at least a disease. On the other hand, individuals were divided in sarcopenic obese group (SOG), or non-sarcopenic obese group (NSOB). Sarcopenia was defined following the HGS cut-offs by BMI category as suggested by the European Working Group on Sarcopenia in Older People (Cruz-Jentoft AJ, et col. 2010) and based on the quartiles of Fried et col. (2001) as follow:

- Men:
    - If BMI was ≤ 24 kg/m^2 and HGS was ≤ 29 kg
    - If BMI 24.1–26 kg/m^2 and HGS was ≤ 30 kg
    - If BMI 26.1–28 kg/m^2 and HGS was ≤ 30 kg
    - If BMI > 28 kg/m^2 and HGS was ≤ 32 kg
- Women:
    - If BMI ≤ 23 kg/m^2 and HGS was ≤ 17 kg
    - If BMI 23.1–26 kg/m^2 and HGS was ≤ 17.3 kg
    - If BMI 26.1–29 kg/m^2 and HGS was ≤ 18 kg
    - If BMI > 29 kg/m^2 and HGS was ≤ 21 kg

Obesity was defined according to the World Health Organization (WHO, 2000), as BMI ≥ 30 kg/m^2 and/or central obesity as a waist circumference greater than 102 cm in men and 88 cm in women. When obesity, defined by BMI and/or waist circumference, and sarcopenia were presented, the participant was classified as SOG.

3.4. Blood pressure.

Blood pressure was assessed with a validated automated digital device (Omron HEM 780E) after questionnaires were filled out.

3.5. Body Composition.

Body composition was assessed using anthropometry and bioimpedance analysis (BIA). All procedures followed the next protocol: The last ingestion of food and liquids was 3 hours before doing the measurements; participants refrained from taking tea, coffee, chocolate or any other kind of stimulants, also they did not perform any intense exercises or efforts during the previous 24 hours.

Anthropometry. The height and weight were measured to the nearest 0.1 cm and 0.1 kg respectively with a stadiometer (Seca, Hamburg, Germany) and scale (Tanita BF510, Japan). An inextensible tape (Rosscraft, Canada) was used to obtain waist circumference (WC) and arm circumference to the nearest 0.1 cm. Triceps skinfold was measured with a calibrated caliper (Lange, USA) with 0.1 mm of precision. All measurements were carried out according to the standardized procedures described in the literature (Lohman, T. G., Roche A. F., Martorell, 1988). BMI was calculated using the Quetelet's formula (weight *(kg)* / squared height *(m^2)*).

Bioimpedance Analysis. The percentage of fat mass (%FM) was obtained by single frequency tetrapolar bioimpedance following the procedures of the manufacture (Tanita BF510, Japan, image 1). Briefly, the participants, without shoes in light indoor clothes, stood erect and still over the scale by stepping the feet electrodes. Shoulders were flexed 90º and elbows extended 180º while grapping hand electrodes. They were in this latter position until the device displayed the body composition values.

Image 1. Body composition analyzer tetrapolar monofrequency bioimpedance Tanita BF510

Muscle mass. Regional SMM (arm) was estimated by anthropometry. We used corrected arm muscle area (AMA) estimation since it has been classically accepted and practical in clinical settings (Gurney JM, 1973; Jelliffe EPF, 1969) . The AMA was calculated after measuring triceps skinfold thickness (TSF), and mid-arm circumference (MAC). These measurements were introduced in the mathematical model suggested by Heymsfield (1982), which was based on the following four practical approximations:

a) the mid-arm is circular;

b) the TSF is twice the average fat rim diameter;

c) the mid-arm muscle compartment is circular;

d) and bone, which is included in anthropometric AMA, atrophies in proportion to muscle in protein energy malnutrition. With this procedure, AMA was overestimated between 20 to 25% due to subcutaneous fat, the medial neurovascular sheath and bone.

From women, corrected AMA is:

$$Corrected\ AMA = \frac{(MAC - \pi \times TSF)^2}{4\pi} - 6.5$$ *Equation 1*

From men, corrected AMA is:

$$Corrected\ AMA = \frac{(MAC - \pi \times TSF)^2}{4\pi} - 10$$ *Equation 2*

3.6. Strength.

Handgrip strength (HGS) was measured using a digital hand grip dynamometer (T.K.K.5401, Takei, Japan), which records the maximum reading in kg using the right hand. After adapting handgrip to each subject, participant stand with the right elbow extended along the body without touching the trunk or thigh with the upper limb or dynamometer, respectively. When indicated the participant squeezed the dynamometer as strong as possible during 5 seconds. Two trials were permitted with a rest period of 3 minutes and the maximal measurement was recorded. Additionally a ratio of HGS and AMA was calculated as follow (equation 3):

$$HGS_a = \frac{HGS\,(kg)}{AMA\,(cm^2)}$$ *Equation 3*

3.7. Statistical Analyses.

Statistical analysis was performed using PASW Statistics for Windows version 18.0, 2010 (SPSS Inc., an IBM Company, Chicago IL, USA). Descriptive analysis included means, standard deviation, maximum and minimum. Ranks and medians were used when variables were not normally distributed. Normality test Kolmogorov-Smirnov was used to analyze normal distribution of variables.

We expected to detect correlation coefficients as low as 0.25, which assuming a type I error of 0.001 and 80% of statistical power can be found with a sample size of 95 individuals.

Additionally, if we want to detect a $R^2 = 0.15$ in a regression model with 5 independent predictor variables, a type I error of 0.05 and 80% of statistical power, we will need a minimum sample size of 91. We could recruit 103 participants, which allowed us enough statistical power to carry out the main statistical procedures in a reliable way.

Independent sample *T*-test and Mann-Whitney test were used to compare differences between groups (sex, SOG, NSOG, HG or UHG), for normal and non-normal distribution respectively.

Pearson's coefficient correlation was used to analyze the associations between strength variables and independent variables. Spearman correlation coefficient was utilized when non normal distribution was detected. These previous correlations were conducted for the total sample and for unhealthy and healthy groups adjusted for age and in the same way for SOG and NSOG. Graphical representation of this partial correlations were performed by computing the residual of the regression between age and dependent variables, and on the other hand by computing residual from the regression between independent variables and age, both residuals were plotted in order to examine graphically the association between variables adjusted for age.

Stepwise linear regression analysis was used to estimate significant predictors of HGS using nutrition, body composition and PA variables as independent variables.

A *p* value of 0.05 was used as limit of significance for all statistics procedures.

4. RESULTS

Descriptive characteristics are showed in table 1. Our volunteers were overweight on average, although some of them were close to the low weight as verified by the minimum value (19.6 kg/m^2), which can be confirmed from the %FM data with range between 15.2% and 50.7%. Additionally, these participants were centrally obese as described by a mean WC of 95.8 cm. Blood pressure statistics indicated there were a wide range of healthy profiles, due to a low number of cases of hypertension (16, table 1). Regarding PA Score our questionnaire informed of low levels of total daily PA. Means of HGS and HGSA were 73.8 kg and 0.8 kg/cm^2, respectively. Finally, we have got well balance sex (chi-squared=24.61, p>0.005; table 3A), also the healthy group had lower probability of not getting medication than the unhealthy group (chi-squared=22.22, $p<0.005$; table 3B)

Table 1. Characteristic of the sample

Variables		Mean	SD	Min	Max	Sig.[1]
Age	*(years)*	61.16	± 7.74	50.00	84.00	-
Sex	*(M/F)*		48/55			-
Height	*(cm)*	164.12	± 8.74	143.50	190.00	-
Weight	*(kg)*	70.43	± 12.33	48.10	116.00	-
% FM	*(%)*	31.30	± 9.29	15.20	50.70	*
FFM	*(kg)*	48.29	± 10.27	33.65	80.85	-
BMI	*(kg/m^2)*	26.09	± 3.61	19.64	37.55	-
FFMI	*(kg/m^2)*	17.76	± 2.46	12.71	24.33	*
FMI	*(kg/m^2)*	8.33	± 3.24	3.20	18.00	-
WC	*(cm)*	95.75	± 11.32	70.00	135.00	-
SBP	*(mmHg)*	129.6	± 19.1	80.0	176.0	-
DBP	*(mmHg)*	73.8	± 10.0	49.0	105.0	*
HGS	*(kg)*	73.8	± 10.0	49.0	105.0	-
HGSA	*(kg/cm^2)*	.8	± .3	.3	1.7	-
HR	*(bpm)*	69.2	± 9.9	45.0	99.0	*
PAQ-O_Score		7.00	± 4.86	.00	17.68	-
Hipertension	*(Yes/No)*		(16/87)			-
Smoke	*(Yes/No)*		(16/87)			-
Disease	*(Yes/No)*		(69/34)			-

SD, Standard Deviation; Min, minimum; Max, maximum; Sig, statistical significant; FM, fat mass; FFM, fat free mass; BMI, body mass index; FFMI, fat free mass index; FMI, fat mass index; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; HR, heart rate; PAQ-O_Score, physical activity questionnaire for older people.
1, Kolmogorov-Smirnov test for normality distribution.
*, It indicates normality distribution

Nutrition descriptive is showed in table 2. Means of total daily energy intake (TDEI) is 2113 kcal/day, total protein grams is 112.0 g and percentage of protein is 21.2% of the TDEI.

Table 2. Characteristics of nutrition

Variables		Mean	SD	Min	Max	Sig.[1]
TDEI	(kcal/day)	2113.4	± 867.9	583.0	4024.0	-
%_prot	*(%)*	21.2	± 4.2	14.0	32.5	-
%_ch	*(%)*	50.7	± 9.8	29.0	73.0	-
%_fat	*(%)*	28.1	± 8.8	2.0	45.0	-
Prot_I_kg	*(gr/d/kg)*	1.5	± .6	.4	3.5	-
Prot_I_kgFFM	*(gr/d/kgFFM)*	2.3	± 1.0	.6	4.7	-
gr_prot	*(gr)*	112.0	± 53.3	27.4	260.9	-

SD, Standard Deviation; Min, minimum; Max, maximum; Sig, statistical significant; TDEI, total daily energy intake; %_prot, percentage of protein; %_ch, percentage of carbohydrates; %_fat, percentage of fat; Prot_I_kg, protein intake per kg of body weight; Prot_I_kgFFM, protein intake per kg of fat free mass; g_prot, total protein grams.
1, Kolmogorov-Smirnov test for normality distribution.
*, It indicates normality distribution

Table 3A. Chi-square for male and female group, healthy and unhealthy group

Variables	**Healthy** *(n=34)*	**Unhealthy** *(n=69)*
Male	21	27
Female	13	42

Chi-squared=24.609,
$p>0.005$

Table 3B. Chi-square for medication and non-medication group and healthy and unhealthy group

Variables	**Healthy** *(n=34)*	**Unhealthy** *(n=69)*
No_medica	30	27
Yes_medica	4	42

Chi-squared=22.222
$p<0.005$

Human body composition in healthy (n=34) and unhealthy (n=69) groups is shown in table 4. On average, weight was lower in the healthy (65.4 kg) than the unhealthy group (72.9 kg), as %FM was 24.7% and 34.6%, respectively. Unhealthy group (UHG) was overweight on average (27.3 kg/m^2) and healthy group (HG) (25.2 kg/m^2) was a normal BMI. Although healthy group had the lowest arm muscle area (42.7cm^2), they performed the highest value of strength per area (0.88kg/cm^2).

Table 4. Body composition in healthy and unhealthy group

Variables		Healthy Group (n=34)							Unhealthy (n=69)							
		Mean		SD	Min	Max	Range	Sig.[1]	Mean		SD	Min	Max	Range	Sig.[1]	Sig.[2]
Age	*(years)*	59.24	±	7.25	50.00	72.00	22.00	-	62.10	±	7.48	50.00	84.00	34.00	-	-
Weight	*(kg)*	65.41	±	10.30	48.10	86.30	38.20	*	72.91	±	12.57	52.20	116.00	63.80	-	$$
% FM	*(%)*	24.68	±	6.81	15.70	37.30	21.60	*	34.56	±	8.62	15.20	50.70	35.50	*	+++
BMI	*(kg/m^2)*	23.72	±	2.08	19.64	27.99	8.35	*	27.25	±	3.65	20.51	37.55	17.04	*	+++
WC	*(cm)*	87.08	±	7.78	70.00	102.50	32.50	-	100.02	±	10.34	82.10	135.00	52.90	-	$$$
AC	*(cm)*	30.32	±	3.52	25.00	40.50	15.50	-	31.93	±	3.65	25.20	40.30	15.10	*	$
A_Skindfold	*(mm)*	20.96	±	8.24	7.55	36.40	28.85	*	19.26	±	6.75	5.20	37.75	32.55	*	-
HGS	*(kg)*	33.98	±	11.01	19.00	60.00	41.00	-	28.49	±	9.97	13.00	53.00	40.00	-	$
AMA	*(cm^2)*	42.71	±	19.97	17.55	93.63	76.08	*	43.14	±	15.63	20.32	90.27	69.95	*	-
HGSA	*(kg/cm^2)*	.88	±	.30	.39	1.72	1.33	-	.69	±	.22	.32	1.35	1.03	-	$$
FFM	*(kg)*	49.47	±	9.87	33.65	64.40	30.75	*	47.70	±	10.49	33.91	80.85	46.94	-	-
FFMI	*(kg)*	17.89	±	2.44	12.71	22.09	9.38	*	17.69	±	2.47	13.17	24.33	11.16	-	-
FMI	*(kg)*	5.82	±	1.56	3.54	8.73	5.19	*	9.56	±	3.15	3.20	18.00	14.80	*	+++

SD, Standard Deviation; Min, minimum; Max, maximum; Sig, statistical significant; % FM, percentage of fat mass; BMI, body mass index; WC, waist circumference; AC, Arm circumference; A_Skinfold, arm skinfold; AMA, arm muscle area; HGSA: hand grip strength corrected by arm area; FFM, fat free mass; FFMI, fat free mass index; FMI, fat mass index.

1, Kolmogorov-Smirnov test for normality distribution.

*, It indicates normality distribution; $ Mann-Whitney

2. Difference between groups

$, It indicates significant difference Mann-Whitney test, $p<0.05$

$$, It indicates significant difference Mann-Whitney test, $p<0.01$

$$$, It indicates significant difference Mann-Whitney test, $p<0.001$

Table 5. Body composition in male and female group

Variables		Total Sample (n=103)					Male (n=48)						Female (n=55)						
		Mean	SD	Min	Max	Range	Mean	SD	Min	Max	Range	Sig.[1]	Mean	SD	Min	Max	Range	Sig.[1]	Sig.[2]
WEIGHT	*(kg)*	70.43	± 12.33	48.10	116	67.90	76.55	± 12.56	59.30	116	56.70	*	65.09	± 9.38	48.10	94.80	46.70	-	$$$
% FM	*(%)*	31.30	± 9.29	15.20	50.70	35.50	23.87	± 6.04	15.20	38.70	23.50	-	37.78	± 6.28	22.10	50.70	28.60	-	$$$
BMI	*(kg/m^2)*	26.09	± 3.61	19.64	37.55	17.91	26.38	± 3.47	21.06	37.55	16.49	*	25.83	± 3.75	19.64	37.03	17.39	-	-
WC	*(cm)*	95.75	± 11.32	70	135	65	97.15	± 10.46	83.50	125	41.50	-	94.53	± 11.99	70	135	65	-	-
AC	*(cm)*	31.40	± 3.67	25	40.50	15.50	32.39	± 3.72	26.50	40.50	14	-	30.53	± 3.43	25	40.10	15.10	-	$
FFM	*(kg/m^2)*	48.29	± 10.27	80.85	33.65	47.20	57.75	± 6.72	80.85	46.92	33.93	-	40.03	± 3.31	48.73	33.65	15.08	-	$$$
FFMI	*(kg/m^2)*	17.76	± 2.46	24.33	12.71	11.63	19.92	± 1.60	24.33	16.97	7.36	-	15.87	± 1.18	19.03	12.71	6.33	-	$$$
FMI	*(kg/m^2)*	8.33	± 3.24	18.00	3.20	14.80	6.46	± 2.41	13.22	3.20	10.02	-	9.96	± 3.00	18.00	4.42	13.58	-	$$$

SD, Standard Deviation; Min, minimum; Max, maximum; Sig, statistical significant; % FM, percentage of fat mass; BMI, body mass index; WC, waist circumference; AC, Arm circumference; FFM, fat free mass; FFMI, fat free mass index; FMI, fat mass index.

1, Kolmogorov-Smirnov test for normality distribution.

*, It indicates normality distribution

2. Difference between groups

$, It indicates significant difference Mann-Whitney test, $p<0.05$

$$$, It indicates significant difference Mann-Whitney test, $p<0.001$

In table 5, human body composition variables were presented by gender groups. In male group, mean of weight (76.6kg), BMI (25.8kg/m^2), waist circumference (97.2cm), arm circumference (32.4cm), FFM (57.6kg/m^2), and FFMI (19.9 kg/m^2) were higher than means of female group. In female group, means of %FM (37.8%) and FMI (9.96kg/m^2) were higher.

PA variables in healthy and unhealthy group are presented in Table 6. In unhealthy group, means of HGS (28.49kg) , HGSA (0.69kg/cm^2) and score of PAQ-O (6.98) are lower than means in healthy group, but mean of time sit in unhealthy group (2.48 hours) was higher than in healthy group (2.21 hours). Healthy group had the highest sport score mean (5.27). We found significant differences in HGS, HGSA and house score between healthy and unhealthy group (table 6).

Table 6. Physical activity in healthy and unhealthy group

Variables		Healthy (n=34)						Unhealthy (n=69)						
		Mean	SD	Min	Max	Range	Sig.[1]	Mean	SD	Min	Max	Range	Sig.[1]	Sig.[2]
HGS	*(kg)*	33.98	± 11.01	19.00	60.00	41.00	-	28.49	± 9.97	13.00	53.00	40.00	-	$
HGSA	*(kg/cm²)*	.88	± .30	.39	1.72	1.33	-	.69	± .22	.32	1.35	1.03	*	$$
PAQ-O_Score		7.04	± 4.74	.00	15.42	1.42	-	6.98	± 4.95	.00	17.68	17.68	-	-
House_Score		1.56	± .73	.00	3.00	3.00	-	1.91	± .69	.00	3.00	3.00	-	$$
Sport_Score		5.27	± 4.56	.00	13.04	13.04	-	4.82	± 4.60	.00	14.78	14.78	-	-
Activity_Score		.20	± .86	.00	4.00	4.00	-	.25	± .85	.00	4.00	4.00	-	-
Sit_Time	*(hours)*	2.21	± .98	1.00	4.00	3.00	-	2.48	± 1.34	1.00	6.00	5.00	-	-

SD, Standard Deviation; Min, minimum; Max, maximum; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; PAQ-O_Score, Physical Activity Questionnaire for older people score.
1, Kolmogorov-Smirnov test for normality distribution.
*, It indicates significance for normal distribution.
2. Difference between groups
$, It indicates significant difference Mann-Whitney test, $p<0.05$
$$, It indicates significant difference Mann-Whitney test, $p<0.01$

Table 7 shows male group had higher score on PAQ-O (7.14) and sport score (5.31), higher levels of HGS (39.33kg) and higher level of HGSA on average than females, although spent more time seated (table 7). Additionally, HGS in female group was lower on average (22.43kg) and range (11.65kg), they had also a significantly higher house score than men (2.07, table 7).

Table 7. Physical activity in male and female groups.

Variables		Male (n=48)						Female (n=55)						
		Mean	SD	Min	Max	Range	Sig.[1]	Mean	SD	Min	Max	Range	Sig.[1]	Sig.[2]
HGS	*(kg)*	39.33	± 7.97	25.00	60.05	35.05	-	22.43	± 4.58	12.55	29.20	16.65	-	$$$
HGSA	*(kg/cm^2)*	.81	± .29	.39	1.72	1.33	*	.71	± .22	.31	1.22	.91	-	-
PAQ-O_Score		7.14	± 4.85	.00	14.64	14.64	*	6.88	± 4.91	.00	17.68	17.68	*	-
House_Score		1.48	± .70	.00	3.00	3.00	*	2.07	± .61	.00	3.00	3.00	*	+++
Sport_Score		5.31	± 4.58	.00	13.04	13.04	*	4.67	± 4.58	.00	14.78	14.78	*	-
Activity_Score		.34	± 1.06	.00	4.00	4.00	*	.14	± .60	.00	3.00	3.00	*	-
Sit_Time	*(hours)*	2.50	± 1.32	1.00	6.00	5.00	*	2.29	± 1.15	1.00	4.00	3.00	*	-

SD, Standard Deviation; Min, minimum; Max, maximum; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; PAQ-O_Score, Physical Activity Questionnaire for older people score.
1, Kolmogorov-Smirnov test for normality distribution.
*, It indicates normality distribution
2. Difference between groups
+++, It indicates significant difference Test-t; $p<0.001$
$$$, It indicates significant difference Mann-Whitney; $p<0.001$

Regarding body composition and strength associations, negative Pearson's correlation coefficients were found between arm skinfold and HGS (-0.649), %FM and HGS (-0.638), fat mass index and HGS (-0.458), arm muscle area and HGSA (-0.481), %FM and HGSA (-0.432), BMI and HGSA (-0.428) and, finally, fat mass index and HGSA (-0.488) (table 8). As expected, the relationship between muscularity and lean tissue resulted in positive Pearson's correlation coefficients between arm muscle area and HGS (0.654), body weight and HGS (0.503); likewise the non-parametric Spearman's correlation coefficient was positive between FFM and HGS (0.833) and fat free mass index and HGS (0.715) (table 8).

Table 8. Correlation between body composition and strength.

Variables		HGS (n=103)		HGSA (n=103)	
		Corr	Sig.	Corr	Sig.
Skinfold	*(mm)*	-.643	***[a]	-.124	-
AMA	*(cm^2)*	.654	***[a]	-.481	***[a]
BW	*(kg)*	.503	*[a]	-.239	-
%FM	*(%)*	-.638	***[a]	-.432	***[a]
BMI	*(kg/m^2)*	.079	-	-.428	***[a]
FFM	*(kg/m^2)*	.833	***[b]	-.210	-
FFMI	*(kg/m^2)*	.715	***[b]	-.089	-
FMI	*(kg/m^2)*	-.458	***[a]	-.488	***[a]

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; Skinfold, skinfold arm; AMA, arm muscle area;; PAQ-O_Score, Physical Activity Questionnaire for older people score; BW, body weight; % FM, percentage of fat mass; BMI, body mass index; FFM, fat free mass; FFMI, fat free mass index; FMI, fat mass index.
*[a], it indicates statistical significant Pearson's correlation, $p<0.05$
***[a], it indicates statistical significant Pearson's correlation, $p<0.005$
***[b], it indicates statistical significant Spearman's correlation, $p<0.005$

Table 9 shows correlations between strength variables and nutrition variables. Positive Spearman's correlation coefficients were found between calories and HGS (0.320) and total protein grams and HGS (0.344), and negative coefficients between percentage of carbohydrates and HGS (-0.218, table 9). There was also a positive Pearson's correlation coefficient between protein intake per kg of FFM and HGS (0.288, table 9).

Table 9. Correlation between strength and nutrition.

Variables		HGS *(n=54)*		HGSA *(n=54)*	
		Corr	Sig.	Corr	Sig.
TDEI	(kcal/day)	.320	*[b]	-.131	-
%_prot	*(%)*	.153	-	.085	-
%_ch	*(%)*	-.218	*[b]	.069	-
%_fat	*(%)*	.162	-	.032	-
Prot_I_kg	*(gr/d/kg)*	.314	-	.230	-
Prot_I_kgFFM	*(gr/d/kgFFM)*	.288	*[a]	-.038	-
g_prot	*(gr)*	.344	*[b]	-.117	-

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; TDEI, total daily energy intake; %_prot, percentage of protein; %_ch, percentage of carbohydrates; %_fat, percentage of fat; Prot_I_kg, protein intake per kg of body weight; Prot_I_kgFFM, protein intake per kg of fat free mass; g_prot, total protein grams.
*[a], it indicates statistical significant Pearson's correlation, $p>0.05$
*[b], it indicates statistical significant Spearman's correlation, $p>0.05$

Correlations between strength and PA variables are showed in table 10. A negative correlation was found between house score and HGS (-0.355) and a significant and positive correlation between activity score and HGS (0.236).

Table 10. Correlation between strength and physical activity.

Variables		HGS *(n=103)*		HGSA *(n=103)*	
		Corr	Sig.	Corr	Sig.
Sit_time	*(hours)*	.118	-	.172	-
PAQ-O_Score		.450	-	.054	-
Activity_Score		.236	*	-.106	-
Sport_Score		.063	-	.039	-
House_Score		-.355	***	-.091	-

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area Corr, correlation; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; PAQ-O_Score, Physical Activity Questionnaire for older people score.
*[a], it indicates statistical significant Pearson's correlation, $p<0.05$
***[a], it indicates statistical significant Pearson's correlation, $p<0.005$

In table 11, a significant correlation was found in female group between HGS and sit time (0.311).

Table 11. Correlations between strength and physical activity in male and female group.

Variables		Male (n=48)				Female (n=55)			
		HGS		HGSA		HGS		HGSA	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
Sit_time	*(hours)*	-.123	-	.720	-	.311	*[a]	.259	-
PAQ-O_Score		.026	-	-.009	-	.079	-	.009	-
Activity_Score		.245	-	-.169	-	.199	-	-.640	-
Sport_Score		-.019	-	.026	-	.060	-	.026	-
House_Score		-.067	-	.022	-	-.009	-	-.054	-

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; PAQ-O_Score, Physical Activity Questionnaire for older people score.
*[a], it indicates statistical significant Pearson's correlation, $p<0.05$

In healthy group, activity score and HGS were the only significantly associated variables (0.334) (table 12). While in unhealthy group, positive correlations were found between HGSA and sit time (0.309), HGSA and sport score (0.271) and negative correlation between house score and HGS (-0.396, table 12).

Table 12. Correlations between strength and physical activity in healthy and unhealthy group.

Variables		Healthy (n=34)				Unhealthy (n=69)			
		HGS		HGSA		HGS		HGSA	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
Sit_time	*(hours)*	.218	-	-.012	-	.119	-	.309	**[b]
PAQ-O_Score		.026	-	-.040	-	.060	-	.900	-
Activity_Score		.334	**[b]	-.037	-	.156	-	-.158	-
Sport_Score		-.024	-	-.094	-	.071	-	.271	*[b]
House_Score		-.257	-	-.137	-	-.396	**[b]	-.028	-

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; PAQ-O_Score, Physical Activity Questionnaire for older people score.
*[b], it indicates statistical significant Spearman's correlation, $p<0.05$
**[b], it indicates statistical significant Spearman's correlation, $p<0.01$

Table 13 shows correlations in male and female groups between strength and nutritional variables. Both females and males associations with HGS were positive, conversely HGSA was always negatively correlated.

Table 13. Correlation between strength and nutrition in male and female group.

Variables		Male (n=48)				Female (n=55)			
		HGS		HGSA		HGS		HGSA	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
TDEI	(kcal/day)	.315	-	-.448	*[b]	.324	-	.265	-
%_prot	*(%)*	.122	-	-.023	-	.311	-	.247	-
%_ch	*(%)*	.014	-	.090	-	-.216	-	-.163	-
%_fat	*(%)*	-.209	-	-.168	-	-.045	-	.020	-
Prot_I_kg	*(gr/d/kg)*	.210	-	-.261	-	.393	-	.320	-
Prot_I_kgFFM	*(gr/d/kgFFM)*	.364	*[b]	-.265	-	.388	-	.324	-
g_prot	*(gr)*	.412	*[b]	-.296	-	.432	*[b]	-.612	***[b]

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; TDEI, total daily energy intake; %_prot, percentage of protein; %_ch, percentage of carbohydrates; %_fat, percentage of fat; Prot_I_kg, protein intake per kg of body weight; Prot_I_kgFFM, protein intake per kg of fat free mass; g_prot, total protein grams.
*[b], it indicates statistical significant Spearman correlation, $p<0.05$
***[b], it indicates statistical significant Spearman correlation, $p<0.005$

Regarding to disease status, only participants in the healthy group had significant correlations, specifically positive associations between g_prot and HGS (0.342) and negative correlations between %_ch and HGS (-0.516) were found (table 14).

Table 14. Correlation between strength and nutrition in healthy and unhealthy group.

Variables		Healthy (n=34)				Unhealthy (n=69)			
		HGS		HGSA		HGS		HGSA	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
TDEI	(kcal/day)	.406	-	-.075	-	.236	-	-.052	-
%_prot	*(%)*	.180	-	.320	-	.145	-	.026	-
%_ch	*(%)*	-.516	*[b]	-.118	-	-.216	-	.039	-
%_fat	*(%)*	.408	-	.015	-	.108	-	-.118	-
Prot_I_kg	*(gr/d/kg)*	.309	-	.200	-	.268	-	.025	-
Prot_I_kgFFM	*(gr/d/kgFFM)*	.095	-	.263	-	-.009	-	.086	-
g_prot	*(gr)*	.342	*[b]	.144	-	.311	-	.005	-

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; TDEI, total daily energy intake; %_prot, percentage of protein; %_ch, percentage of carbohydrates; %_fat, percentage of fat; Prot_I_kg, protein intake per kg of body weight; Prot_I_kgFFM, protein intake per kg of fat free mass; g_prot, total protein grams.
*[b], it indicates statistical significant Spearman's correlation, $p<0.05$

Table 15 shows correlations between body composition variables and strength. In male group positive correlations between HGS and AMA (0.496), BW (0.337), FFM (0.518) and FFMI (0.310); negative correlations were observed between HGSA and AMA (-0.727), BW (-0.368), %FM (-0.351), BMI (-0.323) and FMI (-0.421). In female group, a positive correlation was found between HGS and FFM (0.275) and negative correlations between HGSA and AMA (-0.762), BW (-0.548), %FM (-0.557), BMI (-0.605), FFM (-0.290), FFMI (-0.464) and FMI (-0.612).

Table 15. Correlation between body composition and strength in male and female group.

Variables		**Male** *(n=48)*				**Female** *(n=55)*			
		HGS		**HGSA**		**HGS**		**HGSA**	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
Skinfold	*(mm)*	.078	-	.047	-	.223	-	.172	-
AMA	*(cm^2)*	.496	***[a]	-.727	***[a]	.178	-	-.762	***[a]
BW	*(kg)*	.337	*[b]	-.368	*[b]	.153	-	-.548	***[b]
%FM	*(%)*	-.053	-	-.351	*[b]	-.071	-	-.557	***[b]
BMI	*(kg/m^2)*	.121	-	-.323	*[a]	-.093	-	-.605	***[a]
FFM	*(kg/m^2)*	.518	***[a]	-.140	-	.275	*[a]	-.290	*[a]
FFMI	*(kg/m^2)*	.310	*[a]	-.141	-	-.088	-	-.464	***[a]
FMI	*(kg/m^2)*	-.025	-	-.401	*[b]	-.780	-	-.612	***[b]

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; Skinfold, skinfold arm; AMA, arm muscle area; BW, body weight; % FM, percentage of fat mass; BMI, body mass index; FFM, fat free mass; FFMI, fat free mass index; FMI, fat mass index.

*[a], it indicates statistical significant Pearson's correlation, $p<0.05$

***[a], it indicates statistical significant Pearson's correlation, $p<0.005$

*[b], it indicates statistical significant Spearman's correlation, $p<0.05$

***[b], it indicates statistical significant Spearman's correlation, $p<0.005$

In table 16, in healthy group, positive correlations were found between AMA and HGS (0.644), BW and HGS (0.884), FFM and HGS (0.905), FFMI and HGS (0.719) and negative correlations between HGS and %FM (-0.551), HGS and FMI (-0.345) and HGSA and AMA (-0.593). In unhealthy group, we found positive correlations between AMA and HGS (0.703), BW and HGS (0.475), FFM and HGS (0.781), FFMI and HGS (0.662) and negative correlations between HGS and %FM (-0.652), HGS and FMI (-0.441), HGSA and AMA (-0.432), HGSA and BW (-0.243), HGSA and %FM (-0.433), HGSA and BMI (-0.440) and HGSA and FMI (-0.500).

Table 16. Correlation between body composition and strength in healthy and unhealthy group

Variables		**Healthy** *(n=34)*				**Unhealthy** *(n=69)*			
		HGS		**HGSA**		**HGS**		**HGSA**	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
Skinfold	*(mm)*	-.146	-	.234	-	.036	-	.033	-
AMA	*(cm^2)*	.644	**[a]	-.593	**[a]	.703	**[a]	-.432	**[a]
BW	*(kg)*	.884	**[b]	-.260	-	.475	**[b]	-.243	**[b]
%FM	*(%)*	-.551	**[a]	-.159	-	-.652	**[a]	-.433	**[a]
BMI	*(kg/m^2)*	.669	**[a]	-.133	-	.100	-	-.440	**[a]
FFM	*(kg/m^2)*	.905	**[b]	-.211	-	.781	**[b]	.030	-
FFMI	*(kg/m^2)*	.719	**[b]	-.188	-	.662	**[b]	-.070	-
FMI	*(kg/m^2)*	-.345	**[a]	-.213	-	-.441	**[a]	-.500	**[a]

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; Skinfold, skinfold arm; AMA, arm muscle area; BW, body weight; % FM, percentage of fat mass; BMI, body mass index; FFM, fat free mass; FFMI, fat free mass index; FMI, fat mass index.
**[a], it indicates statistical significant Pearson's correlation, $p<0.01$
**[b], it indicates statistical significant Spearman's correlation, $p<0.01$

Table 17 shows us correlations controlling for age. Negative correlations were found between skinfold and HGS (-0.643), %FM (-0.642), FMI (-0.456), and HGSA and AMA (-0.482), %FM (-0.440), BMI (-0.417) and FMI (-0.484). Positive correlations resulted from all

variables significantly associated with HGS, such as AMA (0.656), BW (0.512), FFM (0.842) and FFMI (0.774).

Table 17. Correlation between body composition and strength controlling for age.

Variables		**HGS** *(n=103)*		**HGSA** *(n=103)*	
		Corr	Sig.	Corr	Sig.
Skinfold	*(mm)*	-.643	***	-.124	-
AMA	*(cm^2)*	.656	***	-.482	***
BW	*(kg)*	.512	***	-.230	*
%FM	*(%)*	-.642	***	-.440	***
BMI	*(kg/m^2)*	.097	-	-.417	***
FFM	*(kg/m^2)*	.842	***	.094	-
FFMI	*(kg/m^2)*	.774	***	.048	-
FMI	*(kg/m^2)*	-.456	***	-.484	***

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; Skinfold, skinfold arm; AMA, arm muscle area;; PAQ-O_Score, Physical Activity Questionnaire for older people score; BW, body weight; % FM, percentage of fat mass; BMI, body mass index; FFM, fat free mass; FFMI, fat free mass index; FMI, fat mass index.
*, it indicates statistical significant, $p<0.05$
**, it indicates statistical significant, $p<0.01$
***, it indicates statistical significant, $p<0.005$

Correlations between strength and nutrition variables are presented in table 18. HGS and TDEI (0.332), protein intake per kg of body weight (0.287) and total protein grams (0.350) were positively correlated. But none significant association was found with HGSA.

Table 18. Correlation between strength and nutrition controlling for age

Variables		**HGS** *(n=103)*		**HGSA** *(n=103)*	
		Corr	Sig.	Corr	Sig.
TDEI	(kcal/day)	.332	*	-.156	-
%_prot	*(%)*	.135	-	.840	-
%_ch	*(%)*	-.209	-	-.146	-
%_fat	*(%)*	.149	-	.130	-
Prot_I_kg	*(gr/d/kg)*	.287	*	-.084	-
Prot_I_kgFFM	*(gr/d/kgFFM)*	.015	-	-.180	-
g_prot	*(gr)*	.350	*	-.129	-

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; TDEI, total daily energy intake; %_prot, percentage of protein; %_ch, percentage of carbohydrates; %_fat, percentage of fat; Prot_I_kg, protein intake per kg of body weight; Prot_I_kgFFM, protein intake per kg of fat free mass; g_prot, total protein grams.
*, it indicates statistical significant, $p<0.05$
**, it indicates statistical significant, $p<0.01$
***, it indicates statistical significant, $p<0.005$

Correlations between strength variables and PA variables controlling for age are showed in table 19. A positive correlation was found between HGS and activity score (0.231, table 19), however house score was negatively associated, even after controlling for age (r =-0.369, $p<0.001$; figure 4).

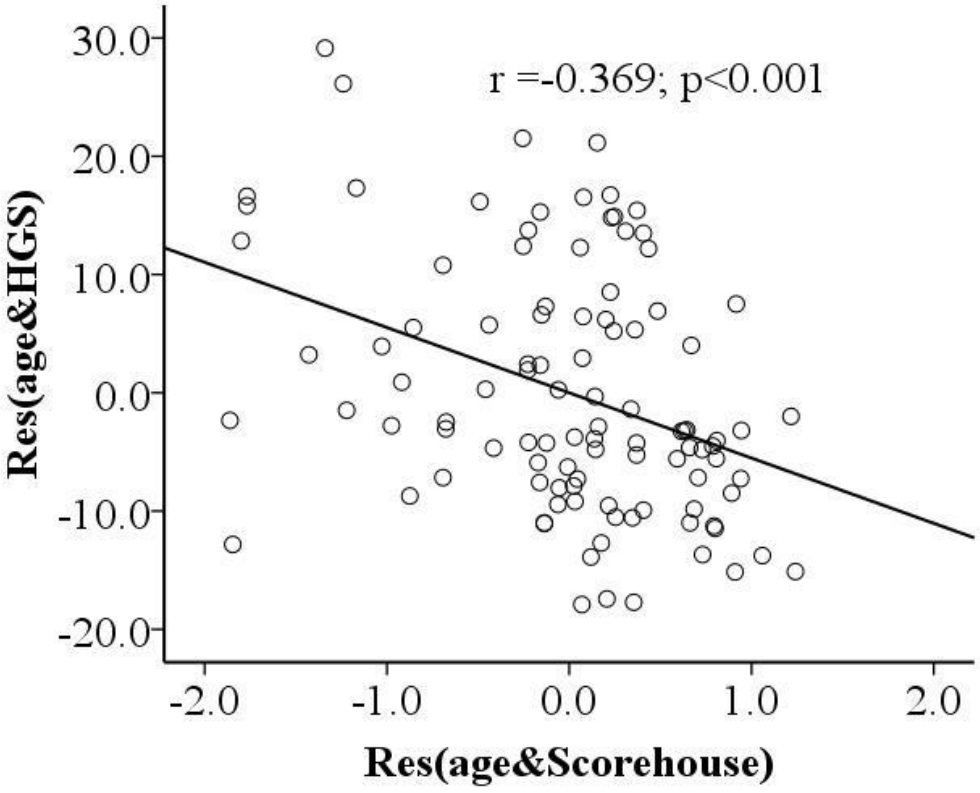

Figure 4. Scatter plot representing adjusted correlation by age between score house and hand strength. Y-axis units are residuals of hand grip strength and age regression and X-axis are residuals of score house and age regression.

Table 19. Correlation between strength and physical activity after controlling for age.

Variables		**HGS** *(n=103)*		**HGSA** *(n=103)*	
		Corr	Sig.	Corr	Sig.
Sit_time	*(hours)*	.094	-	.176	-
PAQ-O_Score		.048	-	.004	-
Activity_Score		.231	*	-.125	-
Sport_Score		.066	-	.044	-
House_Score		-.369	***	-.111	-

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; PAQ-O_Score, Physical Activity Questionnaire for older people score.

*, it indicates statistical significant, $p<0.05$

***, it indicates statistical significant, $p<0.005$

In table 20 we can observe correlations adjusted for age, positive correlations were found in male group between HGS and AMA (0.370), FFM (0.436) and FFMI (0.360); and negative between HGSA and AMA (-0.764), %FM (-0.398) and FMI (-0.384) in male group.

In female group, we obtained positive associations between HGS and skinfold (0.313) and AMA (0.359); and negative between HGSA and AMA (-0.763), BMI (-0.511), %FM (-0.412), BMI (-0.498), FFM (-0.437), FFMI (-0.386), and FMI (-0.460, table 20).

Table 20. Correlation between body composition and strength controlling for age in male and female group.

Variables		**Male** *(n=48)*				**Female** *(n=55)*			
		HGS		**HGSA**		**HGS**		**HGSA**	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
Skinfold	*(mm)*	-.029	-	.242	-	.313	*	.125	-
AMA	*(cm^2)*	.370	*	-.764	***	.359	**	-.763	***
BW	*(kg)*	.263	-	-.277	-	.242	-	-.511	***
%FM	*(%)*	-.060	-	-.398	**	.140	-	-.412	**
BMI	*(kg/m^2)*	.180	-	-.332	*	.163	-	-.498	***
FFM	*(kg/m^2)*	.436	**	-.118	-	.224	-	-.437	**
FFMI	*(kg/m^2)*	.360	*	-.143	-	.071	-	-.386	**
FMI	*(kg/m^2)*	.020	-	-.384	**	.173	-	-.460	***

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; Skinfold, skinfold arm; AMA, arm muscle area; BW, body weight; % FM, percentage of fat mass; BMI, body mass index; FFM, fat free mass; FFMI, fat free mass index; FMI, fat mass index.
*, it indicates statistical significant, $p<0.05$
**, it indicates statistical significant, $p<0.01$
***, it indicates statistical significant, $p<0.005$

In table 21, positive correlations controlling for age were found in healthy group between HGS and AMA (0.658), BW (0.806), BMI (0.678), FFM (0.885) and FFMI (0.831), and negative with %FM (-0.585), FMI (-0.363) and AMA (-0.575).

HGS and AMA (0.713), BW (0.545), FFM (0.830) and FFMI (0.749) were positively correlated in the unhealthy group after adjusting for age (table 21).

Table 21. Correlation between body composition and strength controlling for age in healthy and unhealthy group.

Variables		Healthy (n=34)				Unhealthy (n=69)			
		HGS		HGSA		HGS		HGSA	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
Skinfold	*(mm)*	-.147	-	.252	-	.036	-	-.004	-
AMA	*(cm^2)*	.658	***	-.575	***	.713	***	-.414	***
BW	*(kg)*	.806	***	-.149	-	.545	***	-.158	-
%FM	*(%)*	-.585	***	-.105	-	-.656	***	-.466	***
BMI	*(kg/m^2)*	.678	***	-.166	-	.104	-	-.411	***
FFM	*(kg/m^2)*	.885	***	-.069	-	.830	***	.155	-
FFMI	*(kg/m^2)*	.831	***	-.038	-	.749	***	.057	-
FMI	*(kg/m^2)*	-.363	*	-.169	-	-.441	***	-.505	***

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; Skinfold, skinfold arm; AMA, arm muscle area; BW, body weight; % FM, percentage of fat mass; BMI, body mass index; FFM, fat free mass; FFMI, fat free mass index; FMI, fat mass index.
*, it indicates statistical significant, $p<0.05$
***, it indicates statistical significant, $p<0.005$

Positive correlations controlling for age were found in male group between total protein grams and HGS (0.365) and negative correlations between TDEI and HGSA (-0.386, table 22).

Table 22. Correlation between strength and nutrition controlling for age in male and female group

Variables		Male (n=48)				Female (n=55)			
		HGS		HGSA		HGS		HGSA	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
TDEI	(kcal/day)	.295	-	-.386	*	.217	-	-.025	-
%_prot	*(%)*	.280	-	.007	-	.113	-	.037	-
%_ch	*(%)*	-.085	-	.022	-	-.322	-	-.128	-
%_fat	*(%)*	.083	-	-.004	-	.318	-	.190	-
Prot_I_kg	*(gr/d/kg)*	.323	-	-.249	-	.179	-	.088	-
Prot_I_kgFFM	*(gr/d/kgFFM)*	.284	-	-.308	-	.153	-	.019	-
g_prot	*(gr)*	.365	*	-.332	-	.248	-	-.068	-

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; TDEI, total daily energy intake; %_prot, percentage of protein; %_ch, percentage of carbohydrates; %_fat, percentage of fat; Prot_I_kg, protein intake per kg of body weight; Prot_I_kgFFM, protein intake per kg of fat free mass; g_prot, total protein grams.
*, it indicates statistical significant, $p<0.05$

In table 23, positive correlations controlling for age were found in healthy group between TDEI and HGS (0.686), total protein grams and HGS (0.575). In unhealthy group, positive correlations controlling for age, were found between HGSA and total protein grams (0.342).

Table 23. Correlation between strength and nutrition controlling for age in healthy and unhealthy group

Variables		Healthy (n=34)				Unhealthy (n=69)			
		HGS		HGSA		HGS		HGSA	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
TDEI	(kcal/day)	.686	*	-.297	-	.280	-	-.045	-
%_prot	*(%)*	.035	-	.117	-	.191	-	.066	-
%_ch	*(%)*	-.155	-	-.272	-	-.204	-	-.010	-
%_fat	*(%)*	.249	-	.421	-	.077	-	-.074	-
Prot_I_kg	*(gr/d/kg)*	.452	-	-.080	-	.299	-	.024	-
Prot_I_kgFFM	*(gr/d/kgFFM)*	.177	-	-.154	-	.025	-	-.102	-
g_prot	*(gr)*	.575	*	-.172	-	.342	*	-.055	-

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; TDEI, total daily energy intake; %_prot, percentage of protein; %_ch, percentage of carbohydrates; %_fat, percentage of fat; Prot_I_kg, protein intake per kg of body weight; Prot_I_kgFFM, protein intake per kg of fat free mass; g_prot, total protein grams.
*, it indicates statistical significant, $p<0.05$

Table 24 shows positive correlation in female group controlling for age between sit time and HGS (0.361).

Table 24. Correlation between strength and physical activity controlling for age in male and female group

Variables		Male (n=48)				Female (n=55)			
		HGS		HGSA		HGS		HGSA	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
Sit_time	*(hours)*	-.121	-	.069	-	.425	**	.361	-
PAQ-O_Score		.020	-	-.007	-	.080	-	.000	-
Activity_Score		.163	-	-.153	-	.114	-	-.196	-
Sport_Score		.008	-	.021	-	.070	-	.030	-
House_Score		-.158	-	.035	-	.012	-	-.040	-

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; PAQ-O_Score, Physical Activity Questionnaire for older people score.
*, it indicates statistical significant, $p<0.05$
**, it indicates statistical significant, $p<0.01$
***, it indicates statistical significant, $p<0.005$

Table 25 shows positive correlations in healthy group between activity score and HGS (0.457) and positive correlations in unhealthy group between sport score and HGSA (0.306). Negative correlations were found in unhealthy group between house score and HGS (-0.326).

Table 25. Correlation between strength and physical activity controlling for age in healthy and unhealthy group

Variables		**Healthy** *(n=34)*				**Unhealthy** *(n=69)*			
		HGS		**HGSA**		**HGS**		**HGSA**	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
Sit_time	*(hours)*	.250	-	.119	-	.071	-	.292	*
PAQ-O_Score		.058	-	-.059	-	.043	-	.077	-
Activity_Score		.457	*	-.018	-	.142	-	-.173	-
Sport_Score		.026	-	-.072	-	.068	-	.306	*
House_Score		-.326	-	.100	-	-.326	*	-.110	-

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; PAQ-O_Score, Physical Activity Questionnaire for older people score.
*, it indicates statistical significant, $p<0.05$

We found differences among male and female groups percentage of FM, FFMI, FMI and FM, both in SOG (n=44) and NSOG (n=59) in (table 26). However, we did not observe significant differences between SOG and NSOG for the same sex group (table 26).

Table 26. Descriptive sarcopenic obese group and non sarcopenic obese group body composition and difference between male and female group.

Variables		No sarcopenic obesity (n=59)				Male (n=30)	Female (n=29)	Mann-Whitney
		Mean	SD	Min	Max	Mean Rank	Mean Rank	Sig.
%FM	*(%)*	31.10	± 9.28	15.70	50.70	16.05	44.43	***
BMI	*(kg/m^2)*	26.20	± 3.06	21.38	37.55	29.78	30.22	-
WC	*(cm)*	95.96	± 9.71	74.70	123.50	29.02	31.02	-
FFMI	*(kg/m^2)*	17.93	± 2.38	13.60	24.33	44.17	15.34	***
FMI	*(kg/m^2)*	8.27	± 3.03	3.71	15.78	18.53	41.96	***
FM	*(kg)*	48.91	± 10.42	33.65	80.85	44.50	15.00	***
Variables		**Sarcopenic obesity** *(n=44)*				Male *(n=18)*	Female *(n=26)*	**Mann-Whitney**
		Mean	SD	Min	Max	Mean Rank	Mean Rank	Sig.
%FM	*(%)*	31.58	± 9.40	15.20	50.20	12.78	29.23	***
BMI	*(kg/m^2)*	25.93	± 4.28	19.64	37.03	25.03	20.75	-
WC	*(cm)*	95.46	± 13.30	70.00	135.00	25.08	20.71	-
FFMI	*(kg/m^2)*	17.53	± 2.57	12.71	23.49	34.94	13.88	***
FMI	*(kg/m^2)*	8.40	± 3.53	3.20	18.00	16.17	26.88	**
FM	*(kg)*	47.45	10.13	33.72	72.88	35.39	13.58	***

SD, Standard Deviation; Min, minimum; Max, maximum; Sig, statistical significant; % FM, percentage of fat mass; BMI, body mass index; WC, waist circumference; FFMI, fat free mass index; FMI, fat mass index; FM fat mass.
Difference between groups
**, It indicates significant difference Mann-Whitney test, $p<0.005$
***, It indicates significant difference Mann-Whitney test, $p<0.001$

This study showed a positive association in the SOG, between HGS and FFM, FFMI, AMA, skinfold and BW. HGSA had negative association with BMI (-0.434), AMA (-0.588), skinfold (-0.683), percentage of FM (-0.358) and BW (-0.377). On the other hand, in the NSOG we obtained positive correlation coefficients between HGS and several variables: FFM (0.820), FFMI (0.706), AMA (0.616) and BW (0.461), and negative correlation with BMI (-0.162), WC (-0.425), AMA (-0.428), skinfold (-0.645), percentage of FM (-0.419) and BW (-0.332, table 27).

Table 27. Correlation between strength and body composition in sarcopenic obese group and non sarcopenic obese group

Variables		SOG (n=44)				NSOG (n=59)			
		HGS		HGSA		HGS		HGSA	
		Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]	Corr	Sig.[1]
BMI	*(kg/m^2)*	.158	-	-.434	**[a]	.007	-	-.162	***[a]
FFM	*(kg)*	.845	***[a]	-.013	-	.820	***[a]	.127	-
FFMI	*(kg/m^2)*	.746	***[a]	-.085	-	.706	***[a]	.068	-
WC	*(cm)*	.079	-	.880	**[a]	.034	-	-.425	***[a]
AMA	*(cm^2)*	.718	***[a]	-.588	***[a]	.616	***[a]	-.428	**[a]
A_ Skinfold	*(mm)*	.427	**[b]	-.683	***[b]	.226	-	-.645	***[b]
%FM	*(%)*	-.516	***[b]	-.358	**[b]	-.723	***[b]	-.419	**[b]
BW	*(kg)*	.565	***[b]	-.377	**[b]	.461	***[b]	-.332	*[b]

Corr, correlation coefficient; Sig, statistical significant; HGS, hand grip strength; HGSA, hand grip strength corrected by arm area; BMI, body mass index; FFM, fat free mass; FFMI, fat free mass index; WC, waist circumference; AMA, arm muscle area; A_Skinfold, skinfold arm; ; % FM, percentage of fat mass; BW, body weight.

*[a], it indicates statistical significant Pearson's correlation, $p<0.05$

**[a], it indicates statistical significant Pearson's correlation, $p<0.01$

***[a], it indicates statistical significant Pearson's correlation, $p<0.005$

*[b], it indicates statistical significant Spearman's correlation, $p<0.05$

**[b], it indicates statistical significant Spearman's correlation, $p<0.01$

***[b], it indicates statistical significant Spearman's correlation, $p<0.005$

Figure 5 shows adjusted correlations by age between score house and HGS in SOG (r = -0.391; $p < 0.05$) and in NSOG (r = -0.383; $p < 0.01$).

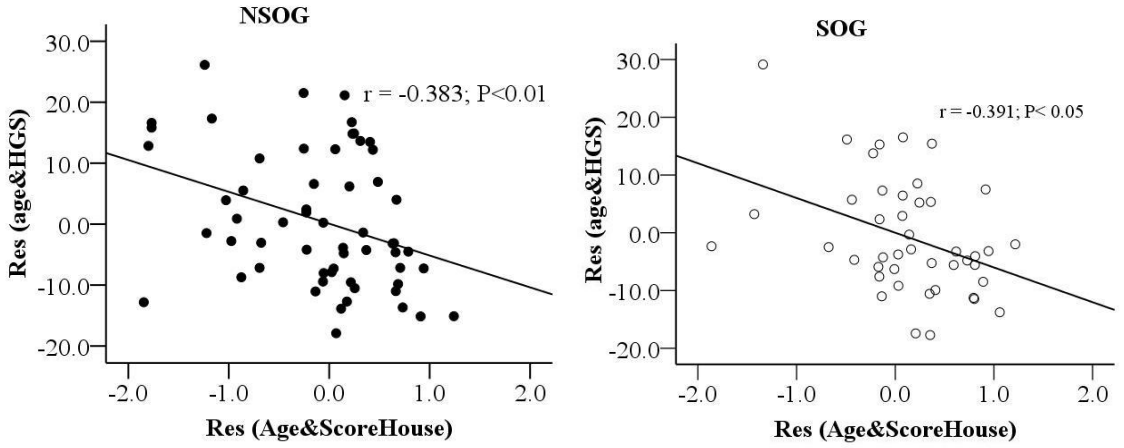

Figure 5. Scatter plot representing adjusted correlation by age between score house and hand grip strength (HGS) in sarcopenic obese group (SOG) and non sarcopenic obese group (NSOG). Y-axis units are residuals of HGS and age regression and X-axis are residuals of score house and age regression.

Figure 6 showed adjusted correlation by age between score activity and HGS in NSOG (r = -0.011; *NS*) and in SOG (r = 0.476; $p < 0.001$).

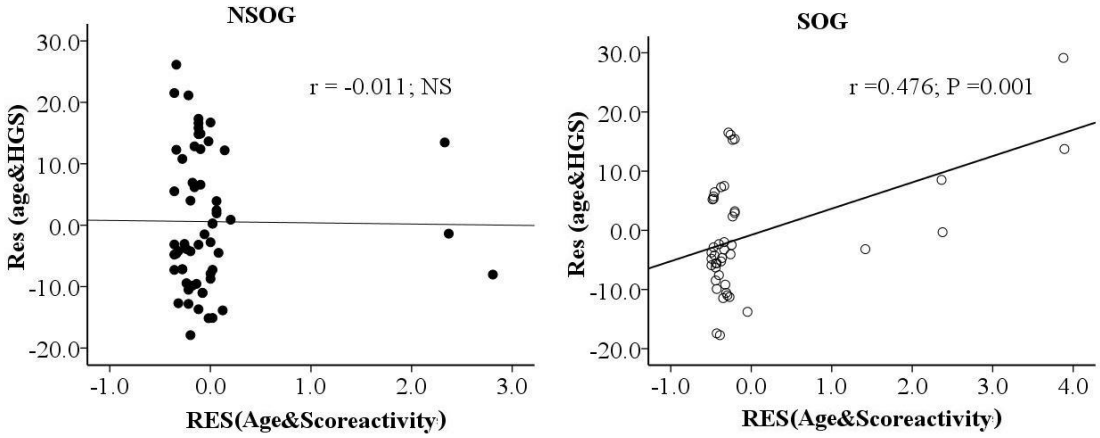

Figure 6. Scatter plot representing adjusted correlation by age between score activity and hand grip strength (HGS) in sarcopenic obese group (SOG) and non sarcopenic obese group (NSOG). Y-axis units are residuals of HGS and age regression and X-axis are residuals of score activity and age regression.

The linear regression model showed that the main predictor of HGS was FFM (SEE= 5.066, R^2 = 0.780, table 28), but splitting in HG (SEE= 5.364, R^2 = 0.770) and UHG (SEE= 4.505, R^2 = 0.805, table 29) was sex.

Table 28. Linear regression model for hand grip strength prediction from sex, age and body composition.

Independent Variables		B	β	Std. Error	Sig.	Change R^2	R^2	SEE
Intercept		35.27		8.24	0.00			
FFM	*(kg)*	0.32	0.31	0.11	0.00	0.688		
Sex	*(0=Male)*	-10.60	-0.50	2.14	0.00	0.027	0.780	5.066
Age	*(years)*	-0.31	-0.23	0.07	0.00	0.049		
AMA	*(cm^2)*	0.10	0.17	0.04	0.01	0.016		

B, regression coefficient; β, standardized regression coefficient; SEE, standard error of estimation; FFM, fat free mass; AMA, corrected arm muscle area from Heymsfield's equation (Heymsfield, McManus, Smith, Stevens, & Nixon, 1982). Dependent variable HGS expressed in kg; n= 103.

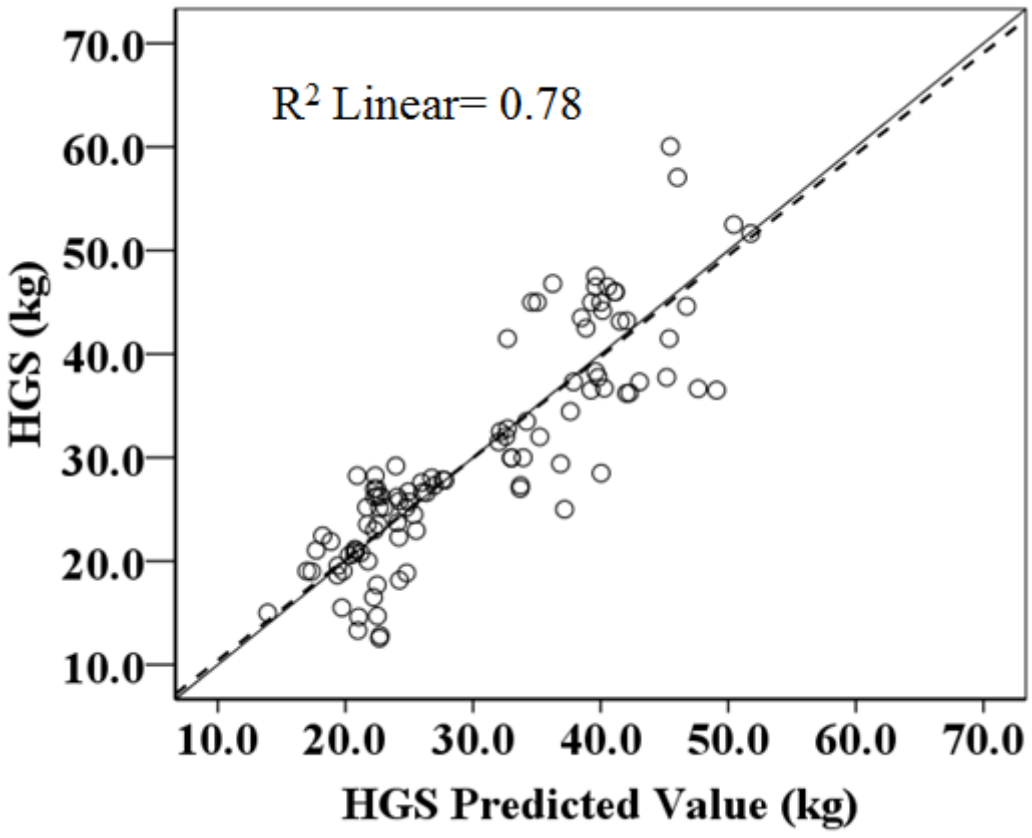

Figure 7. Scatter plot between HGS (hand grip strength) and predicted values of HGS from linear regression analyses. Independent variables= fat free mass, age, sex and corrected arm muscle area. Dashed line represents adjusted regression line and solid line is identity line.

Table 29. Linear regression model for hand grip strength prediction from sex, age and body composition for healthy and unhealthy group.

Independent Variables HG		B	β	Std. Error	Sig.	Change R^2	R^2	SEE
Intercept		-14.412		4.770	.005			
FFM	*(kg)*	.978	.877	.950	.000	0.770	0.770	5.364

Independent Variables UHG		B	β	Std. Error	Sig.	Change R^2	R^2	SEE
Intercept		50.592		5.531	.000			
AMA	*(cm^2)*	.215	.337	.043	.000	.675	0.805	4.505
Sex	*(0=Male)*	-14.267	-.703	1.434	.000	.069		
Age	*(years)*	-.365	-.287	.074	.000	.061		

HG, healthy group; UHG, unhealthy group; B, regression coefficient; β, standardized regression coefficient; SEE, standard error of estimation; AMA, corrected arm muscle area from Heymsfield's equation (Heymsfield et al., 1982). Dependent variable HGS expressed in kg; n= 103.

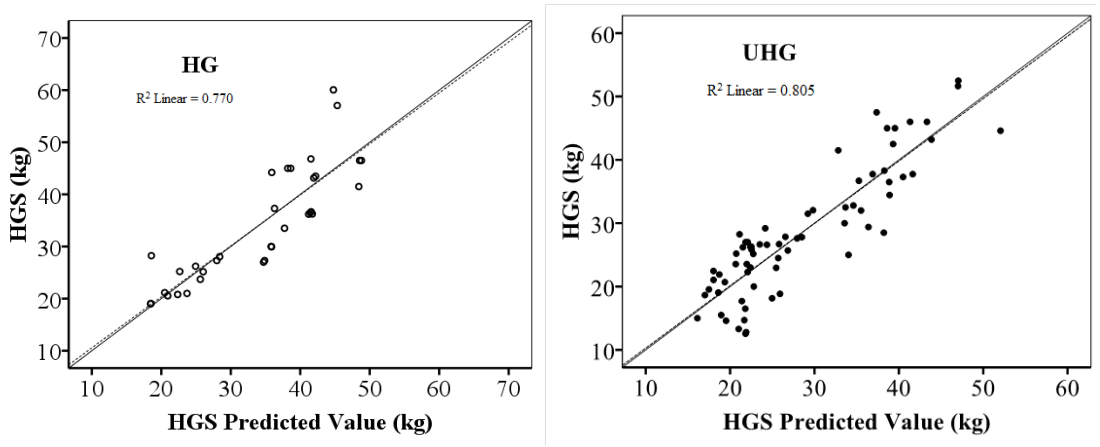

Figure 8. Scatter plot between HGS (hand grip strength) and predicted values of HGS from linear regression analyses for healthy group (HG) on the left side and for unhealthy group (UHG) on the right side. Independent variables= age, sex and corrected arm muscle area. Dashed line represents adjusted regression line and solid line is identity line.

5. DISCUSSION

The aim of this study was to analyze the associations between absolute or relative (per muscle area) HGS and human body composition, nutrition and PA level in people between 50 and 84 years old.

5.1. Nutrition and strength

Our primary finding was that several nutritional variables were significantly associated with HGS, such as TDEI, Prot_I_kgFFM and g_prot (positive correlations), and percentage of carbohydrates (negatively correlated). A plausible explanation for the associations between TDEI and total protein must be the strong correlation between FFM with those variables; as a consequence those participants with more FFM should be stronger than ones with lower as confirmed in our results (Table 8). However, this relationship must be affect by height, so taller participants may have larger FFM and needs of protein. Using the Prot_I_kgFFM ratio might partially resolves the previous artifact and so the observed correlation between HGS and Prot_I_kgFFM could indicate a positive benefit in accordance with a previous study with postmenopausal women conducted by Lemieux et al. (2014), who found higher means of MS (HGS and knee extension) in a group with high Prot-I level. These results may suggest that Prot-I may help to preserve MS and FFM independently of the effect of exercise training as suggested early by Tarnopolsky (1988).

Additionally we could confirm that this effect is not specific for older women, since those positive correlations between HGS and Prot_I_kgFFM and HGS and g_prot were still significant after performing the analysis by sex. These associations confirm evidence from an epidemiological study where (Kim et al. 2013) negative associations between sarcopenia and protein intake in 1156 men (60 years and older) were found. In the same way, Gregorio et al. (2014) analyzed nutrient intake among postmenopausal women 60-90 years old and women who had low protein intake, had lower composite scores of upper and lower extremity HGS. Other study in women conducted by Radavelli-Bagatini et al. (2013), found that women (70-85

years) in third tertile of diary intake (≥2.2 servings/day) had significantly greater appendicular SMM and HGS. Conversely, the analysis by sex showed negative correlations between TDEI and HGS per muscle area in male group, which could be related with an increase in FM depots in the SMM and leading to a less HGS/SMM ratio. The negative correlation between g_prot and HGSA could be also related with a higher calories intake.

All these previous results could be confounded by the effect of disease. In our healthy group, significant positive correlations between HGS and g_prot were observed. Conversely, no significant correlations were found in the unhealthy group, which may suggest that metabolic and cardiovascular diseases (those present in our participants) modify the relationship between strength and g_prot.

After controlling for age, similar results were obtained, but UHG showed a positive correlation between g_prot and HGS; however, when data were adjusted for age and split by sex, male group had a negative correlation between TDEI and HGSA, and positive correlation between HGS and g_prot, but none significant association for female group, likewise a previous study where it has been reported that fat and fit men had lower risk of chronic disease than fat and unfit men (O'Donovan G, Kearney E, Sherwood R, 2012) So, it appears important to be fit to decrease risk of chronic disease, independently of %FM.

5.2. Body composition and strength

As hypothesized a significant association between body composition and strength was observed for all participants and body composition components. So HGS and AMA, HGS and BW, HGS and FFM, and HGS and FFMI were positively correlated, but when we analyzed the same variables per muscle area, correlations became negative or non significant. These findings stand out the necessity of having high levels of total strength in elderly people, because of high level of strength is associated to a better body composition (Sternfeld B, Ngo L, Satariano WA,

2002). HGS and FMI, and HGS and skinfold had a negative correlation, according to Scott's study who found a negative correlation between ambulatory activity and body fat (r = -0.22, P < 0.001) and a positive correlation between ambulatory activity and leg muscle quality (r = 0.17, P < 0.001) (Scott, Blizzard, Fell, & Jones, 2009).

In male group, this study found positive correlations between HGS and body composition variables. Female group obtained positive correlation between HGS and FFM and negative correlations between HGSA and all body composition variables. Likewise a previous study, where was demonstrated that higher levels of body fat are associated with lower physical functioning and greater disability in post-menopausal women (56-73 years) (Lebrun CEI, van der Schouw YT, de Jong FH & SW., 2006). So, it is important to maintain a lower FM level in elderly people, although recent evidence suggests a slight increase in FM with aging may be associated with positive health outcomes, which may support our finding of a positive relationship between triceps skinfold and HGSA.

After dividing HG and UHG, negative correlations of HGS with %FM and HGS with FMI in HG and negative correlations of HGS and HGSA with %FM and HGS and HGSA with FMI in HG evidenced that highs amounts of body fat are more associated with low SMM, according to several studies (Jensen GL, 2005; Jensen GL, 2002; Zamboni M, Turcato E, Santana H, 1999). Age did not affect any results. In addition, male group presented positive correlations between HGS and AMA, FFM and FFMI, and negative associations between HGSA and AMA, BW, %FM, BMI and FMI both male and female, which it appears to indicate a reduction in relative muscle strength with greater levels of hypertrophy. Evidence suggests that this association might be related with a decrease in the number of actomyosin cross-bridge per Prot_I_kg muscle area (D'Antona G, Pellegrino MA, 2003). Additionally, it could be explained with a diminution of the muscular density in people with higher levels of training and SMM(Coggan AR, Spina RJ, Rogers MA, King DS, Brown M, Nemeth PM, 1990; Evans, 1993).

5.3. Physical Activity and strength

As expected, we described a positive correlation among HGS and activity score. This result is in accordance with the positive association of leg strength and ambulatory activity observed by Scott et al. (Scott et al., 2009). Nevertheless, HGS was negatively correlated with house score even after controlling for age. This fact may be paradigmatic since usually household activities require arm movements. We can speculate that those participants with lower levels of HGS were also less active out-home and tend to do over report household work, moreover this association was only significant for women after splitting the results by sex. So, it appears to be that spending more time in out home physical activities than household activities may promote better levels of HGS.

The fact that HGS and sit time had a significant positive correlation in female group, even after adjusting for age, was unexpected and it do not confirm results from Lebrun, who observed that participants with higher muscle strength had a better score in the activities of daily living (Lebrun CEI, van der Schouw YT, de Jong FH & SW., 2006). Nevertheless, this lack of resemblance may be due to subjectivity of questionnaire.

One of the most important results of this study was that it related positively sport score and HGSA in UHG, so it suggests training activities improve quality of SMM, in accordance to positive associations observed in other studies, where leg strength and muscle quality with ambulatory activities in women (Scott et al., 2009) and PA could prevent the lost of strength and skeletal muscle the age-associated loss of muscle strength, and the gain muscle fat infiltration in older people (Goodpaster et al. (2008). This was not similar in HG that had positive correlation between HGS and activity score, but not with HGSA. This could suggest HGSA may be impaired in states of disease but not in healthy old adults and the ratio strength/SMM must be relatively constant with variables commitments of exercise training in this group of age. However, these results may be affect along the aging process in old ages, so according to Roubenoff (R., 2004) PA declines with age and this decline can cause a lower

energy expenditure and gain of FM, and as consequence modify this ratio (strength/SMM , here represented as HGSA); so after adjusting for age, the correlations remained significant.

5.4. Sarcopenic obese group and non-sarcopenic obese group

We did not observed differences in the correlations in SOG and NSOG, which may indicate that the importance of the association between body composition and strength (among HGSA and BMI, HGSA and AMA, HGSA and skinfold, HGSA and %FM, and HGSA and BW) is similar with independence of the level of strength and obesity. So possible consequences related with sarcopenic obesity and sarcopenia as falls, mobility limitations, incident disability and fracture (Moreland JD, Richardson JA, Goldsmith CH, 2004; Nevitt MC, Cummings SR, Kidd S, 1989) should be similar between the groups we have assessed. Still, it was estrange we could not find differences for any variables between SOG and NSOG.

Methodological issues may affect results discussed in the previous paragraph. Firstly, the criteria we used to split both groups, which must not be sensible enough to detect the minimum significant differences in the main variables. So, we hypothesized FM, FFM, and strength variables would be different among groups if a more sensible has been used; in instance, considering our sample size and the SD of main variables as %FM, FFMI and HGS, there should have been differences as large as 5.178%, 1.371 kg/m^2 and 5.853 kg respectively to find significant differences between SOG and NSOG. On the contrary, HG and UHG had significantly different values for BMI, WC, FMI and sit time, which may have some clinical relevance. This discrepancy may suggest that HGS and BMI cutoffs combination are not valid to detect statistical differences, nevertheless clinical relevance values can be smaller than statistical differences and larger sample size will be necessary to observe them.

5.5. Predictors of strength from regression models

The regression models built to describe the main predictors of HGS showed that FFM predicted 68.8% of HGS. This confirm the evidence in the literature that conferee to FFM high relevance to maintain mobility and functionality. Also, it reinforces the concept of the new reformulated concept of functional body composition, where this latter plays a main role in physical fitness components (herein strength). In HG, β coefficients indicated that each kg of FFM, HGS increased. In UHG, β coefficients indicated that each squared centimeter of arm muscle area, HGS increased.

5.6. Limitations

Several limitations may keep in mind in order to interpreter our inferences. Firstly, methods to estimate PA and nutrition were questionnaires, which may subject to misinterpretation, filling difficulties and bias (over or underreporting). PA behavior can be measured using accelerometers to obtain a valid and more reliable and accurate measurement. Regarding food intake, it is hardly measurable in free-living conditions, so any method available nowadays has important limitations. We use country-adapted and validated food frequency questionnaires, however they have additional limitations in our study and to confirm future hypothesis since this questionnaire does not inform about kind of protein ingested, which is as important concern as reported by Lemieux et al. (Lemieux FC1, Filion ME, Barbat-Artigas S, Karelis AD, 2014), who suggested animal protein intake is associated with a higher SMM index. Also, Spanish sample was reduced because the national version of FFQ was not available at the beginning of the study.

Endurance capacity is a variable classically related with health status that could be useful to complete this study. A step test was initially used to estimate endurance capacity, but it was cut after evaluating 35 participants due to material limitation (heart rate monitor). After that, it was stopped and no more step tests were performed. There should have continued

measuring it and obtaining total number of steps, which is an indirect variable of endurance capacity too.

HGS and HGSA were measured only on right hand. There is possibility that some participants were stronger on the left side. A mean of right and left HGS and HGSA could have been improved the validity of the strength measurement.

The criteria to split the NHG was too general, and more specific division by type of disease would be better for understanding the associations between disease, strength and body composition.

Finally, it exist several criteria to diagnostic sarcopenic obesity, but an exclusive clinical criteria is not completely well established in the literature. We select the criteria that best fit our assessments, which could not be the best to find an actual status of sarcopenic obesity.

6. CONCLUSIONS

- Our findings indicate positive associations between HGS with protein intake; AMA, FFM, FFMI and activity score in HG, even after adjusting for age. Also, UHG had positive association among HGS and AMA, BW, FFM and FFMI, adjusted for age.
- HGS was positively associated with FFM, FFMI, AMA and BW in SOG and NSOG.
- House score had negative correlation with HGS in SOG, HG and UHG, also controlling for age.
- Indicators of adiposity as %FM and FMI had negative association with HGS and HGSA in SOG and NSOG, and in HG and UHG independently of age.
- This study reinforces that higher level of FFM, protein intake and PA lead to physical condition healthy in older adults.
- Finally, based on our regression analysis we suggested that the main determinants of HGS were body composition variables and sex. It was also important to note that the influence of PA and sedentary time was only important in disease status, which confirms the importance of PA for a good health status independently of age. Conversely, adiposity markers were not independent predictor of HGS which suggests that FM must not play an important role for predicting healthy physical condition in older ages.

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8. ANEXES

Anexo 1: Questionário de Funcionalidade e Saúde

Nome Data Nascimento ____/____/_____ Homem__ Mulher

I. QUESTIONÁRIO DE SAÚDE E CAPACIDADE FUNCIONAL

I. 1. DOENÇA CONHECIDA (assinale com uma cruz os casos positivos)

- ☐ Doença cardiovascular ou pulmonar (asma, bronquite, etc) Qual?
- ☐ Doença metabólica (tiróide, renal ou hepática) Qual?
- ☐ Diabetes Tipo?
- ☐ OUTRA Qual?
- ☐ **História Familiar de doença:** Enfarte do miocárdio, revascul. coronária ou morte súbita do ***pai/mãe*** ou outro familiar em primeiro grau do sexo ***masculino/feminino*** antes dos ***55/65*** anos

I. 2. DIFICULDADES CARDIOVASCULARES.

- ☐ Dor, desconforto no peito, pescoço, maxilar ou braços
- ☐ Dificuldades respiratórias em repouso ou durante um esforço moderado
- ☐ Desmaios, tonturas ou perdas de consciência Motivo?
- ☐ Dificuldades em respirar ou problemas respiratórios repentinos durante a noite
- ☐ Palpitações ou taquicardia
- ☐ Edema ou inchaço no tornozelo

I. 3. OUTRAS DOENÇAS E/OU PROBLEMAS DE SAÚDE

- ☐ Doença recente? Especifique:
- ☐ Cirurgias? Motivo e data?
- ☐ Fracturas? Motivo e data?
- ☐ Lesões ARTICULARES? Local, causa e data?
- ☐ Outras:

1.3. DOR ARTICULAR: A seguir escreva o nível de dor em cada articulação.
Se não apresenta dor coloque um "X" no "0".

ARTICULAÇOES	**ESCALA DE DOR**				
	0	POUCO	MODERADO	MUITO	LIMITANTE
PESCOÇO/CERVICAL					
COLUNA DORSAL					
COLUNA LOMBAR					
OMBRO (DIREITO) (ESQUERDO)					
COTOVELO (DIREITO) (ESQUERDO)					
PULSO E MAOS (DIREITO) (ESQUERDO)					
ANCAS (DIREITO) (ESQUERDO)					
JOELHO (DIREITO) (ESQUERDO)					
TORNOZELO E PÉS (DIREITO) (ESQUERDO)					

I. 5. MEDICAMENTOS: Traga uma listagem com aqueles medicamentos que toma (presentemente) **ou que tomou recentemente** (últimos 3 meses) **. NOME E DOSAGEM.**

I.6. ANALÍTICAS: SE TIVER ANÁLISES DE SANGUE ANEXE A ESTE QUESTIONARIO.

ACTIVIDAD 1: **INT:** **HOR/SEM:** **PERIODO** **P CINT**
ACTIVIDAD 2: **INT:** **HOR/SEM:** **PERIODO** **P BRA** **PLI1** **PL2**
ALT **FUERZA 1** **FUERZA2**
PESO **%GRASA:**
PAS
PAD

II. QUESTIONÁRIO DE ESTILO DE VIDA

II.1. DESCANSO (escreva as horas que utiliza para cada actividade)

ACTIVIDADE	Manha	Tarde	Noite	
DURMIR				
SENTADO A DESCANSAR				

II. 2. História Ocupacional (assinale com uma cruz ou escreva um nº aquela que se adapte a sua situação)

PREGUNTA	NUNCA (< 1 vez mês)	ALGUMAS VEZES	A MAIORIA DAS VEZES	SEMPRE
1. Faz o **trabalho leve** de casa? (limpar o pó, lavar a loiça, arranjar a roupa, etc?				
2. Faz o **trabalho pesado** de casa? (limpar o chão e janelas, tirar os sacos do lixo, etc.?				
3. Para quantas pessoas é que limpa a casa? (deve incluir-se a si mesmo; escreva "0" se respondeu "nunca" nas questões 1 e 2)				
4. Quantas divisões limpa, incluindo a cozinha, quartos, garagem, adega, casa de banho, tecto, etc? (marque "0" se respondeu "nunca" nas questões 1 e 2)	0	1-6 Divisões	7-9 Divisões	10 ou mais
5. Se houverem quartos, por quantos andares estão distribuídos? (marque "0", se respondeu "nunca" na questão 4)				

6. Prepara refeições quentes para si? Ou ajuda a preparar?	**Nunca**	**Algumas vezes** (1 ou 2 x semana)	**A maioria das vezes** (3-5 x semana)	**Sempre** (> 5 vezes x semana)
7.Quantas escadas ou pisos sobe por dia? (um piso de escadas são 10 degraus)	0	1-5	6-10	> 10
8.Se vai para algum lado na sua cidade, que tipo de transporte utiliza?	Nunca vou	Carro	Transportes Públicos	Bicicleta / Caminhada
9.Qual é a frequência com que vai às compras?	< 1 vez x semana	1 vez x semana	De 2 a 4 vezes x semana	Todos os dias
10. Se vai às compras, que tipo de transporte utiliza?	Nunca vou	Carro	Transportes Públicos	Bicicleta / Caminhada

12. Quais dos seguintes são assuntos determinantes para o seu bem estar (circule):

ıtonomia; disposição; ausência de dores; Outros, escreva quais:_____

II. 3. Hábitos Diários (assinale com uma cruz na quadrícula respectiva)

É fumador? Se sim, quantos cigarros/dia? _____ Se não, mas já foi, há quanto tempo abandonou? _____ meses/anos

Vive com um fumador? ☐ Sim ☐ Não

Bebe café? Se sim, quantos por dia? _____ ☐ Sim ☐ Não

Quantas refeições faz por dia? _____

Anexo 2: Cuestionario de Funcionalidad y Salud

Nombre Fecha de Nacimento ____/____/_____ Hombre__
Mujer ___

I. CUESTIONARIO DE SALUD Y CAPACIDAD FUNCIONAL

I. 1. ENFERMEDAD CONOCIDA (marque con una cruz los casos positivos)

☐	Enfermedad cardiovascular o pulmonar (asma, bronquitis, etc)	Cual?
☐	Enfermedad metabólica (tiroides, renal o hepática)	Cual?
☐	Diabetes	Tipo?
☐	OTRA	Cual?
☐	**Historia Familiar de enfermedad:** Infarto de miocárdio, revascul. coronaria o muerte súbita del ***padre/madre*** u otro familiar en primer grado del sexo ***masculino/feminino*** antes de los ***55/65*** años	

I. 2. DIFICULTADES CARDIOVASCULARES.

☐	Dolor, desconfort en el pecho, cuello, mandivula o brazos	
☐	Dificultades respiratorias en reposo o durante un esfuerzo moderado	
☐	Desmayos, tonturas o perdidas de consciencia	Motivo?
☐	Dificultades en respirar o problemas respiratorios repentinos durante la noche	
☐	Palpitaciones o taquicardia	
☐	Edema o inflamación en el tobillo	

I. 3. OTRAS ENFERMEDADES Y/O PROBLEMAS DE SALUD

☐	Enfermedad reciente? Especifique:
☐	Cirurgias? Motivo y fecha?
☐	Fracturas? Motivo y fecha?
☐	Lesiones ARTICULARES? Local, causa y fecha?
☐	Otras:

1.3. DOLOR ARTICULAR: A continuación escriba el nível de dolor en cada articulación. Si no presenta dolor coloque una "X" en el "0".

ARTICULACIONES	**ESCALA DE DOR**				
	0	POUCO	MODERADO	MUITO	LIMITANTE
CUELLO/CERVICAL					
COLUMNA DORSAL					
COLUMNA LUMBAR					
HOMBRO (DERECHO) (IZQUIERDO)					
CODO (DERECHO) (IZQUIERDO)					
MUÑECA Y MANOS (DERECHO) (IZQUIERDO)					
CADERA (DERECHO) (IZQUIERDO)					
RODILLA (DERECHO) (IZQUIERDO)					
TOBILLO Y PIES (DERECHO) (IZQUIERDO)					

I. 5. MEDICAMENTOS: Traiga una lista con aquellos medicamentos que toma (actualmente) **o que tomó recientemente** (últimos 3 meses) **. NOMBRE Y DOSIS.**

I.6. ANALÍTICAS: SI TUVIERA ANÁLISIS DE SANGRE ADJÚNTELOS A ESTE CUESTIONARIO.

ACTIVIDAD 1: **INT:** **HOR/SEM:** **PERIODO** **P CINT**
ACTIVIDAD 2: **INT:** **HOR/SEM:** **PERIODO** **P BRA** **PLI1** **PL2**
ALT **FUERZA 1** **FUERZA2**
PESO **%GRASA:**
PAS
PAD

II. CUESTIONARIO DE ESTILO DE VIDA

II.1. DESCANSO (escriba las horas que utiliza para cada actividad)

ACTIVIDAD	Mañana	Tarde	Noche	
DORMIR				
SENTADO DESCANSANDO				

II. 2. Historia Ocupacional (marque con una cruz o escriba el nº de aquella que se adapte a su situación)

PERGUNTA	NUNCA (< 1 vez mes)	ALGUNAS VECES	LA MAYORIA DE LAS VECES	SIEMPRE
1. ¿Hace el **trabajo leve** de casa? (limpiar el polvo, lavar los platos, lavar la ropa, etc?				
2. ¿Hace el **trabajo pesado** de casa? (limpiar el suelo y las ventanas, tirar la basura, etc.?				
3. ¿Para cuántas personas limpia la casa? (debe incluirse a si mismo; escriba "0" si respondió "nunca" en las cuestiones 1 e 2)				
4. ¿Cuántas divisiones limpia, incluiyendo la cocina, cuartos, cochera, bodega, cuarto de baño, techo, etc? (marque "0" si respondió "nunca" en las cuestiones 1 e 2)	0	1-6 Divisiones	7-9 Divisiones	10 o más
5. Si hay cuartos/ habitaciones en diferentes plantas, ¿por cuántas plantas están distribuidos? (marque "0" si respondió "nunca" en las cuestiones 4)				

6. ¿Prepara comidas claientes para si mismo? ¿O ayuda a prepararlas?	**Nunca**	**Algunas veces** (1 o 2 x semana)	**La mayoria de las veces** (3-5 x semana)	**Siempre** (> 5 veces x semana)
7. ¿Cuántas escaleras o pisos sube por día? (un piso de escaleras son 10 escalones)	0	1-5	6-10	> 10
8.Si va para algún lado en su ciudad, ¿qué tipo de transporte utiliza?	Nunca voy	Coche	Transportes Públicos	Bicicleta / Caminando
9. ¿Cuál es la frecuencia con la que va a comprar?	< 1 vez x semana	1 vez x semana	De 2 a 4 veces x semana	Todos los días
10. Si va de compras, ¿qué tipo de transporte utiliza?	Nunca voy	Coche	Transportes Públicos	Bicicleta / Caminhada

12. ¿Cuáles de los siguientes son asuntos determinantes para su bienestar?
Autonomía; disposición; ausencia de dolores; Otros, escriba cuales: _____

II. 3. Hábitos Diarios (marque con una cruz en la casilla respectiva)

¿Es fumador? _____ En caso positivo , ¿cuántos cigarros/dia? _____
Si no es fumador, pero ya fue, hace cuanto tiempo que dejó de fumar? _____ meses/anos

¿Vive con un fumador? ☐ Si ☐ No

¿Bebe café? En caso positivo, ¿cuántos por dia? _____ ☐ Si ☐ No

¿Cuántas comidas hace al día? _____

Añade sal cuando cocina: Nunca:_____ Un poco:_____ Mucha:_____
Añade sal al plato de comida: Nunca:_____ Un poco:_____ Mucha:_____

ANEXO_3

Unidade de Epidemiologia Nutricional
Serviço de Higiene e Epidemiologia
Faculdade de Medicina do Porto

INSTRUCÕES

• Este questionário tem como objectivo avaliar a sua alimentação. Procure responder às questões de uma forma sincera, indicando aquilo que realmente come e não o que pensa que seria correcto comer.

• O questionário pretende identificar o consumo de alimentos do ano anterior. Assim para cada alimento, deve assinalar, preenchendo o respectivo círculo, quantas vezes por dia, semana ou mês comeu em média cada um dos alimentos referidos nesta lista, **nos últimos 12 meses**. Não se esqueça de assinalar no círculo respectivo os alimentos que nunca come, ou come menos de 1 vez por mês.

Preencha	assim	●
	assim não	⊗ ✓

• Na coluna correspondente à quantidade assinale se a porção que habitualmente come é igual, maior ou menor do que a referida como porção média.

• Para os alimentos que só são consumidos, em determinadas épocas do ano (por ex: cerejas, diospíros, etc.), assinale as vezes em que o alimento foi consumido nessa época, e coloque uma cruz **(x)** na última coluna (Sazonal).

Preencha	assim	☒
	assim não	☐ ☑

• Não se esqueça de ter em conta as vezes que o alimento é consumido sozinho e aquelas em que é adicionado a outros alimentos ou pratos (ex: café com leite, os ovos das omeletas, etc).

• No grupo III - **Óleos e Gorduras** - responda apenas ao que é **adicionado** em saladas, no prato, no pão, etc, e **não** à utilizada para cozinhar.

• No grupo VI - **Hortaliças e Legumes** - responda pensando nos que são **consumidos no prato** (cozidos ou em saladas) e **não** nos que entram na confecção da sopa.

• No item nº 86, anote a frequência com que come sopa de legumes. Quando consome caldo verde, canja ou sopa instantânea, com uma frequência de **pelo menos 1 vez por semana**, deve assinalar este consumo separadamente no quadro existente para outros alimentos, tendo o cuidado em o subtrair à frequência que referiu anteriormente para a sopa de legumes.

• Se houver algum alimento não mencionado na lista de alimentos e que consuma pelo menos 1 vez por semana, assinale, no quadro que existe para **outros alimentos**, a respectiva frequência e indique ainda a porção média de consumo. **Por ex: frutos tropicais, sumos de fruta natural, bebidas espirituosas, café de mistura, alheiras, farinheiras, frutos secos (figo, ameixa, damasco), produtos dietéticos,**

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avor, **antes de iniciar o questionário leia as instruções da página anterior.**
se durante o último ano quantas vezes por dia, semana ou mês, em média, consumiu cada um dos alimentos eridos. Na coluna referente à quantidade deverá assinalar se sua porção é igual, menor ou maior do que a referida mo porção média. Para os alimentos consumidos só em determinadas épocas do ano, anote a frequência com que alimento é consumido nessa época e assinale com uma cruz **(x)** na última coluna (Sazonal).

I. P. LÁCTEOS	Frequência alimentar									Quantidade				Sazonal
	Nunca ou <1 mês	1-3 por mês	1 por sem	2-4 por sem	5-6 por sem	1 por dia	2-3 por dia	4-5 por dia	6 + por dia	Porção Média	A sua porção é: Menor	Igual	Maior	
1. Leite gordo	○	○	○	○	○	○	○	○	○	1 chávena = 250 ml	○	○	○	☐
2. Leite meio-gordo	○	○	○	○	○	○	○	○	○	1 chávena = 250 ml	○	○	○	☐
3. Leite magro	○	●	○	○	○	○	○	○	○	1 chávena = 250 ml	○	●	○	☐
4. Iogurte	○	○	○	●	○	○	○	○	○	Um =125g	○	●	○	☐
5.Queijo (de qualquer tipo incluindo queijo fresco e requeijão)	○	○	○	○	●	○	○	○	○	1 fatia = 30g	○	●	○	☐
6. Sobremesas lácteas: pudim, aletria e leite creme , etc	○	●	○	○	○	○	○	○	○	Um ou 1 prato sobremesa	○	●	○	☐
7. Gelados	○	○	○	●	○	○	○	○	○	Um ou 2 bolas	○	●	○	☐

II. OVOS, CARNES E PEIXES	Frequência alimentar									Quantidade				Sazonal
	Nunca ou <1 mês	1-3 por mês	1 por sem	2-4 por sem	5-6 por sem	1 por dia	2-3 por dia	4-5 por dia	6 + por dia	Porção Média	A sua porção é: Menor	Igual	Maior	
8.Ovos	○	●	○	○	○	○	○	○	○	Um	○	●	○	☐
9.Frango	○	●	○	○	○	○	○	○	○	2 peças ou 1/4 de frango	○	●	○	☐
10.Peru, coelho	○	●	○	○	○	○	○	○	○	1 porção ou 2 peças	○	●	○	☐
11.Carne vaca, porco,cabrito	○	○	○	●	○	○	○	○	○	1 porção =120g	○	●	○	☐
12. Fígado de vaca, porco, frango	○	●	○	○	○	○	○	○	○	1 porção = 120g	○	●	○	☐
13 Língua, mão de vaca, tripas, chispe, coração, rim	●	○	○	○	○	○	○	○	○	1 porção =100g	●	○	○	☐
14.Fiambre, chouriço, salpição, presunto, etc	○	●	○	○	○	○	○	○	○	2 fatias ou 3 rodelas	○	●	○	☐
15. Salsichas	●	○	○	○	○	○	○	○	○	3 médias	●	○	○	☐
16. Toucinho, bacon	○	○	○	○	○	○	○	○	○	2 fatias	○	○	○	☐
17. Peixe gordo: sardinha, cavala, carapau, salmão,	○	○	○	●	○	○	○	○	○	1 porção =125g	○	●	○	☐
18. Peixe magro: pescada, faneca, dourada, etc	○	○	○	●	○	○	○	○	○	1 porção =125g	○	●	○	☐
19.Bacalhau	○	●	○	●	○	○	○	○	○	1 posta média	○	●	○	☐
20.Peixe conserva: atum, sardinhas,etc	○	○	●	○	○	○	○	○	○	1 lata	○	●	○	☐
21.Lulas, polvo	○	●	○	○	○	○	○	○	○	1 porção =100g	○	●	○	☐
22.Camarão, amêijoas, mexilhão, etc	○	●	○	○	○	○	○	○	○	1 prato sobremesa	○	●	○	☐

III. Óleos e Gorduras	Frequência alimentar									Quantidade				Sazonal
	Nunca ou <1 mês	1-3 por mês	1 por sem	2-4 por sem	5-6 por sem	1 por dia	2-3 por dia	4-5 por dia	6-4 por dia	Porção Média	A sua porção é: Menor	Igual	Maior	
23. Azeite	○	○	○	○	●	○	○	○	○	1 colher sopa	○	●	○	☐
24. Óleos: girassol, milho, soja	○	○	○	○	○	○	○	○	○	1 colher sopa	○	○	○	☐
25. Margarina	○	○	○	○	○	○	○	○	○	1 colher chá	○	○	○	☐
26. Manteiga	○	●	○	○	○	○	○	○	○	1 colher chá	○	●	○	☐

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IV PÃO, CEREAIS E SIMILARES	Frequência alimentar: Nunca ou <1 mês	1-3 por mês	1 por sem	2-4 por sem	5-6 por sem	1 por dia	2-3 por dia	4-5 por dia	6 + por dia	Quantidade: Porção Média	A sua porção é: Menor	Igual	Maior	Saltar
27. Pão branco ou tostas	○	●	○	○	○	○	○	○	○	Um ou 2 tostas	○	●	○	☐
28. Pão (ou tostas), integral,centeio, mistura	○	○	○	●	○	○	○	○	○	Um ou 2 tostas	○	●	○	☐
29. Broa, broa de avintes	○	○	○	○	○	○	○	○	○	1 fatia = 80g	○	○	○	☐
30. Flocos cereais (muesli, corn-flakes, chocapic,etc.)	○	○	○	●	○	○	○	○	○	1 chávena sem leite	○	●	○	☐
31. Arroz	○	○	○	●	○	○	○	○	○	½ prato	○	●	○	☐
32. Massas: esparguete, macarrão, etc.	○	○	●	○	○	○	○	○	○	½ prato	○	●	○	☐
33. Batatas fritas caseiras	○	○	○	○	○	○	○	○	○	½ prato	○	○	○	☐
34. Batatas fritas de pacote	○	○	○	○	○	○	○	○	○	1 pacote pequeno	○	○	○	☐
35. Batatas cozidas, assadas, estufadas e puré	○	○	○	●	○	○	○	○	○	2 batatas médias	○	●	○	☐

V DOCES E PASTÉIS	Frequência alimentar: Nunca ou <1 mês	1-3 por mês	1 por sem	2-4 por sem	5-6 por sem	1 por dia	2-3 por dia	4-5 por dia	6 + por dia	Quantidade: Porção Média	A sua porção é: Menor	Igual	Maior	Saltar
36. Bolachas tipo maria, água e sal ou integrais	○	○	○	●	○	○	○	○	○	3 bolachas	○	●	○	☐
37. Outras bolachas ou biscoitos	○	○	●	○	○	○	○	○	○	3 bolachas	○	●	○	☐
38. Croissant, pasteis, bolicao, doughnut ou bolos	○	●	○	○	○	○	○	○	○	Um; 1 fatia	○	●	○	☐
39.Chocolate (tablete ou em pó)	○	○	●	○	○	○	○	○	○	3 quadrados; 1 colher sopa	○	○	●	☐
40. Snacks de chocolate (Mars, Twix, Kit Kat, etc)	○	○	○	○	○	○	○	○	○	Um	○	○	○	☐
41. Marmelada, compota, geleia, mel	○	○	○	●	○	○	○	○	○	1 colher sobremesa	○	●	○	☐
42. Açúcar	○	○	○	○	○	○	○	○	○	1 colher sobremesa; 1 pacote	○	○	○	☐

VI HORTALIÇAS E LEGUMES	Frequência alimentar: Nunca ou <1 mês	1-3 por mês	1 por sem	2-4 por sem	5-6 por sem	1 por dia	2-3 por dia	4-5 por dia	6 + por dia	Quantidade: Porção Média	A sua porção é: Menor	Igual	Maior	Saltar
43. Couve branca, couve [illegible]barda	○	○	●	○	○	○	○	○	○	½ chávena	○	●	○	☐
44. Penca, Tronchuda	○	○	○	○	○	○	○	○	○	½ chávena	○	○	○	☐
45. Couve galega	○	○	○	○	○	○	○	○	○	½ chávena	○	○	○	☐
46. Brócolos	○	●	○	○	○	○	○	○	○	½ chávena	○	●	○	☐
47. Couve-flor, Couve-bruxelas	○	○	●	○	○	○	○	○	○	½ chávena	○	●	○	☐
48. Grelos, Nabiças, Espinafres	○	○	○	●	○	○	○	○	○	½ chávena	○	●	○	☐
49. Feijão verde	○	●	○	○	○	○	○	○	○	½ chávena	○	●	○	☐
50. Alface, Agrião	○	○	●	○	○	○	○	○	○	½ chávena	○	●	○	☐
51. Cebola	○	○	○	●	○	○	○	○	○	½ média	○	○	○	☐
52. Cenoura	○	○	○	●	○	○	○	○	○	1 média	○	○	○	☐
53. Nabo	○	○	○	●	○	○	○	○	○	1 médio	○	○	○	☐
54. Tomate fresco	○	○	○	●	○	○	○	○	○	3 rodelas	○	○	○	☐
55. Pimento	○	○	●	○	○	○	○	○	○	6 rodelas	○	○	○	☒
56. Pepino	○	○	●	○	○	○	○	○	○	¼ médio	○	○	○	☒
57. Leguminosas: feijão, grão de bico	○	○	○	●	○	○	○	○	○	1 chávena ou ½ prato	○	○	○	☒
58. Ervilha grão, Fava	○	○	○	●	○	○	○	○	○	½ chávena ou ¼ prato	○	○	○	☒

ID

VII. FRUTOS

	Frequência alimentar									Quantidade				
	Nunca ou <1 mês	1-3 por mês	1 por sem	2-4 por sem	5-6 por sem	1 por dia	2-3 por dia	4-5 por dia	6+ por dia	Porção Média	A sua porção é: Menor	Igual	Maior	Suplemento
59. Maça, pêra	○	○	○	●	○	○	○	○	○	1 média	○	●	○	☐
60. Laranja, Tangerinas	○	○	○	●	○	○	○	○	○	1 média; 2 médias	○	●	○	☐
61. Banana	○	○	○	●	○	○	○	○	○	1 média	○	●	○	☐
62. Kiwi	○	○	●	○	○	○	○	○	○	1 médio	○	●	○	☐
63. Morangos	○	○	●	○	○	○	○	○	○	1 chávena	○	●	○	☒
64. Cerejas	○	○	●	○	○	○	○	○	○	1 chávena	○	○	○	☒
65. Pêssego, Ameixa	○	○	●	○	○	○	○	○	○	1 médio; 3 médias	○	○	○	☒
66. Melão, Melancia	○	○	●	○	○	○	○	○	○	1 fatia média	○	○	○	☒
67. Diospiro	○	○	●	○	○	○	○	○	○	1 médio	○	○	○	☒
68. Figo fresco, Nêsperas, Damascos	○	○	○	●	○	○	○	○	○	3 médios	○	●	○	☐
69. Uvas frescas	○	●	○	○	○	○	○	○	○	1 cacho médio	○	●	○	☒
70. Frutos conserva pêssego, ananás	○	●	○	○	○	○	○	○	○	2 metades ou rodelas	○	●	○	☐
71. Amêndoas, avelãs, nozes, amendoins, pistachio, etc.	○	○	○	●	○	○	○	○	○	½ chávena (descascado)	○	●	○	☐
72. Azeitonas	○	○	●	○	○	○	○	○	○	6 unidades	○	●	○	☐

VIII. BEBIDAS E MISCELANEAS

	Frequência alimentar									Quantidade				
	Nunca ou <1 mês	1-3 por mês	1 por sem	2-4 por sem	5-6 por sem	1 por dia	2-3 por dia	4-5 por dia	6+ por dia	Porção Média	A sua porção é: Menor	Igual	Maior	Suplemento
73. Vinho	○	○	○	○	●	○	○	○	○	1 copo=125m	○	●	○	☐
74. Cerveja	○	○	○	●	○	○	○	○	○	1 garrafa ou 1 lata	○	●	○	☐
75. Bebidas brancas: whisky, aguardente, brandy, etc	○	○	●	○	○	○	○	○	○	1 cálice = 40 ml	○	●	○	☐
76. Coca-cola, pepsi-cola ou outras colas	○	○	○	○	○	○	○	○	○	1 garrafa ou 1 lata	○	○	○	☐
77. Ice-tea	○	○	○	○	○	○	○	○	○	1 garrafa ou 1 lata	○	○	○	☐
78.Outros refrigerantes, sumos de fruta ou néctares embalados	○	●	○	○	○	○	○	○	○	1 garrafa ou 1 copo	○	●	○	☐
79.Café (incluindo pingo, meia de leite e outras bebidas com café)	○	○	○	○	●	○	○	○	○	1 chávena café	○	●	○	☐
80. Chá preto e verde	○	○	●	○	○	○	○	○	○	1 chávena	○	●	○	☐
81. Croquetes, rissóis, bolinhos de bacalhau, etc.	○	○	○	○	○	○	○	○	○	3 unidades	○	○	○	☐
82. Maionese	○	○	○	○	○	○	○	○	○	1 colher sobremesa	○	○	○	☐
83. Molho de tomate, ketchup	○	○	○	○	○	○	○	○	○	1 colher sopa	○	○	○	☐
84. Pizza	○	●	○	○	○	○	○	○	○	Meia pizza-média	○	●	○	☐
85. Hambúrguer	○	●	○	○	○	○	○	○	○	Um médio	○	●	○	☐
86. Sopa de legumes	○	○	○	○	●	○	○	○	○	1 prato	○	●	○	☐

Existe algum alimento ou bebida que eu não tenha mencionado e que tenha consumido pelo menos 1 vez por semana mesmo em pequenas quantidades, ou numa época em particular. Por ex: **frutos tropicais, sumos de fruta natural, bebidas espirituosas, café de mistura, alheiras, farinheiras, frutos secos (figo, ameixa, damasco), produtos dietéticos, rebuçados, etc.**

Outros Alimentos	Frequência alimentar									Quantidade	
	Nunca ou <1 mês	1-3 por mês	1 por sem	2-4 por sem	5-6 por sem	1 por dia	2-3 por dia	4-5 por dia	6+ por dia	Porção Média	Suplemento
Redução	○	○	○	○	○	●	○	○	○		☐
	○	○	○	○	○	○	○	○	○		☐
	○	○	○	○	○	○	○	○	○		☐

IDENTIFICACIÓN DEL PARTICIPANTE

NODO

01. Andalucía-Málaga
02. Andalucía-Sevilla-San Pablo
03. Andalucía-Sevilla-V. Rocío
04. Baleares
05. Catalunya-Barna Norte
06. Catalunya-Barna Sur
07. Catalunya-Reus-Tarragona
08. Madrid Norte
09. Madrid Sur
10. Navarra
11. País Vasco
12. Valencia

marque así

así no marque

NODO | CENTRO | MÉDICO | PACIENTE | VISITA

PÁGINA 1

Por favor, marque una única opción para cada alimento.

Para cada alimento, marque el recuadro que indica la frecuencia de consumo **por término medio** durante el **año pasado**. Se trata de tener en cuenta también la variación verano/invierno. Por ejemplo, si toma helados 4 veces/semana sólo durante los 3 meses de verano, el uso promedio al año es 1/semana

CONSUMO MEDIO DURANTE EL AÑO PASADO

	NUNCA O CASI NUNCA	AL MES	A LA SEMANA			AL DÍA			
		1 - 3	1	2 - 4	5 - 6	1	2 - 3	4 - 6	6 +
I. LACTEOS									
1. Leche entera (1 taza, 200 cc)									
2. Leche semidesnatada (1 taza, 200 cc)									
3. Leche descremada (1 taza, 200 cc)									
4. Leche condensada (1 cucharada)									
5. Nata o crema de leche (1/2 taza)									
6. Batidos de leche (1 vaso, 200 cc)									
7. Yogurt entero (1, 125 gr.)									
8. Yogurt descremado (1, 125 gr.)									
9. Petit suisse (1, 55 gr.)									
10. Requesón o cuajada (1/2 taza)									
11. Queso en porciones o cremoso (1, porción 25 gr.)									
12. Otros quesos: curados, semicurados (Manchego, Bola, Emmental...) (50 gr.)									
13. Queso blanco o fresco (Burgos, cabra...) (50 gr.)									
14. Natillas, flan, puding (1, 130 cc)									
15. Helados (1 cucurucho)									

Un plato o ración de 100-150 gr, excepto cuando se indique otra cosa	NUNCA O CASI NUNCA	AL MES	A LA SEMANA			AL DÍA			
		1 - 3	1	2 - 4	5 - 6	1	2 - 3	4 - 6	6 +
II. HUEVOS, CARNES, PESCADOS									
16. Huevos de gallina (uno)									
17. Pollo o pavo CON piel (1 ración o pieza)									
18. Pollo o pavo SIN piel (1 ración o pieza)									
19. Carne de ternera o vaca (1 ración)									
20. Carne de cerdo (1 ración)									
21. Carne de cordero (1 ración)									
22. Conejo o liebre (1 ración)									
23. Hígado (ternera, cerdo, pollo) (1 ración)									
24. Otras vísceras (sesos, corazón, mollejas) (1 ración)									
25. Jamón serrano o paletilla (1 loncha, 30 gr.)									
26. Jamón York, jamón cocido (1 loncha, 30 gr.)									
27. Carnes procesadas (salchichón, chorizo, morcilla, mortadela, salchichas, butifarra, sobrasada, 50 gr.)									
28. Patés, foie-gras (25 gr.)									
29. Hamburguesa (una, 50 gr.), albóndigas (3 unidades)									
30. Tocino, bacon, panceta (50 gr.)									
31. Pescado blanco: mero, lenguado, besugo, merluza, pescadilla,... (1 plato, pieza o ración)									
32. Pescado azul: sardinas, atún, bonito, caballa, salmón (1 plato, pieza o ración 130 gr.)									
33. Pescados salados: bacalao, salazones (1 ración, 60 gr. en seco)									
34. Ostras, almejas, mejillones y similares (6 unidades)									
35. Calamares, pulpo, chipirones, jibia (sepia) (1 ración, 200 gr.)									
36. Crustáceos: gambas, langostinos, cigalas, etc. (4-5 piezas, 200 gr.)									
37. Pescados y mariscos enlatados al natural (sardinas, anchoas, bonito, atún) (1 lata pequeña o media lata normal, 50 gr.)									
38. Pescados y mariscos en aceite (sardinas, anchoas, bonito, atún) (1 lata pequeña o media lata normal, 50 gr.)									

SUMCO 12637-03-1

Por favor, marque una única opción para cada alimento.

	Un plato o ración de 200 grs, excepto cuando se indique	CONSUMO MEDIO DURANTE EL AÑO PASADO								
		NUNCA O CASI NUNCA	AL MES	A LA SEMANA			AL DÍA			
			1 - 3	1	2 - 4	5 - 6	1	2 - 3	4 - 6	6 +
III. VERDURAS Y HORTALIZAS	39. Acelgas, espinacas									
	40. Col, coliflor, brócoles									
	41. Lechuga, endivias, escarola (100 gr.)									
	42. Tomate crudo (1, 150 gr)									
	43. Zanahoria, calabaza (100 gr.)									
	44. Judías verdes									
	45. Berenjenas, calabacines, pepinos									
	46. Pimientos (150 gr.)									
	47. Espárragos									
	48. Gazpacho andaluz (1 vaso, 200 gr.)									
	49. Otras verduras (alcachofa, puerro, cardo, apio)									
	50. Cebolla (media unidad, 50 gr.)									
	51. Ajo (1 diente)									
	52. Perejil, tomillo, laurel, orégano, etc. (una pizca)									
	53. Patatas fritas comerciales (1 bolsa, 50 gr.)									
	54. Patatas fritas caseras (1 ración, 150 gr.)									
	55. Patatas asadas o cocidas									
	56. Setas, níscalos, champiñones									

	Una pieza o ración	CONSUMO MEDIO DURANTE EL AÑO PASADO								
		NUNCA O CASI NUNCA	AL MES	A LA SEMANA			AL DÍA			
			1 - 3	1	2 - 4	5 - 6	1	2 - 3	4 - 6	6 +
IV. FRUTAS	57. Naranja (una), pomelo (una), o mandarinas (dos)									
	58. Plátano (uno)									
	59. Manzana o pera (una)									
	60. Fresas/fresones (6 unidades, 1 plato postre)									
	61. Cerezas, picotas, ciruelas (1 plato de postre)									
	62. Melocotón, albaricoque, nectarina (una)									
	63. Sandía (1 tajada, 200-250 gr.)									
	64. Melón (1 tajada, 200-250 gr.)									
	65. Kiwi (1 unidad, 100 gr.)									
	66. Uvas (un racimo, 1 plato postre)									
	67. Aceitunas (10 unidades)									
	68. Frutas en almíbar o en su jugo (2 unidades)									
	69. Dátiles, higos secos, uvas-pasas, ciruelas-pasas (150 gr.)									
	70. Almendras, cacahuetes, avellanas, pistachos, piñones (30 gr.)									
	71. Nueces (30 gr.)									
	72. ¿Cuántos días a la semana toma fruta como postre?		0	1	2	3	4	5	6	7

	Un plato o ración (150 gr.)	CONSUMO MEDIO DURANTE EL AÑO PASADO								
		NUNCA O CASI NUNCA	AL MES	A LA SEMANA			AL DÍA			
			1 - 3	1	2 - 4	5 - 6	1	2 - 3	4 - 6	6 +
V. LEGUMBRES Y CEREALES	73. Lentejas (1 plato, 150 gr. cocidas)									
	74. Alubias (pintas, blancas o negras) (1 plato, 150 gr. cocidas)									
	75. Garbanzos (1 plato, 150 gr. cocidos)									
	76. Guisantes, habas (1 plato, 150 gr. cocidas)									
	77. Pan blanco, pan de molde (3 rodajas, 75 gr.)									
	78. Pan negro o integral (3 rodajas, 75 gr.)									
	79. Cereales desayuno (30 gr.)									
	80. Cereales integrales: muesli, copos avena, all-bran (30 gr.)									
	81. Arroz blanco (60 gr. en crudo)									
	82. Pasta: fideos, macarrones, espaguetis, otras (60 gr. en crudo)									
	83. Pizza (1 ración, 200 gr.)									

SUMCO 12637-03 (Ret.) 1

NODO | CENTRO | MÉDICO | PACIENTE | VISITA

PÁGINA 3

marque así

así no marque O / \ X -

Por favor, marque una única opción para cada alimento.

Una cucharada o porción individual. Para freír, untar, mojar en el pan, para aliñar, o para ensaladas, utiliza en total:

CONSUMO MEDIO DURANTE EL AÑO PASADO

	NUNCA O CASI NUNCA	AL MES	A LA SEMANA			AL DÍA			
		1 - 3	1	2 - 4	5 - 6	1	2 - 3	4 - 6	6 +
VI. ACEITES Y GRASAS									
84. Aceite de oliva (una cucharada sopera)									
85. Aceite de oliva extra virgen (una cucharada sopera)									
86. Aceite de oliva de orujo (una cucharada sopera)									
87. Aceite de maíz (una cucharada sopera)									
88. Aceite de girasol (una cucharada sopera)									
89. Aceite de soja (una cucharada sopera)									
90. Mezcla de los anteriores (una cucharada sopera)									
91. Margarina (porción individual, 12 gr.)									
92. Mantequilla (porción individual, 12 gr.)									
93. Manteca de cerdo (10 gr.)									
94. Marca de aceite de oliva que usa habitualmente:	— 0 1 2 3 4 5 6 7 8 9 / 0 1 2 3 4 5 6 7 8 9 (No marque aquí)								

CONSUMO MEDIO DURANTE EL AÑO PASADO

	NUNCA O CASI NUNCA	AL MES	A LA SEMANA			AL DÍA			
		1 - 3	1	2 - 4	5 - 6	1	2 - 3	4 - 6	6 +
VII. BOLLERÍA Y PASTELERÍA									
95. Galletas tipo María (4-6 unidades, 50 gr.)									
96. Galletas integrales o de fibra (4-6 unidades, 50 gr.)									
97. Galletas con chocolate (4 unidades, 50 gr.)									
98. Repostería y bizcochos hechos en casa (50 gr.)									
99. Croissant, ensaimada, pastas de té u otra bollería industrial comercial... (uno, 50 gr)									
100. Donuts (uno)									
101. Magdalenas (1-2 unidades)									
102. Pasteles (uno, 50 gr.)									
103. Churros, porras y similares (1 ración, 100 gr.)									
104. Chocolates y bombones (30 gr.)									
105. Cacao en polvo-cacaos solubles (1 cucharada de postre)									
106. Turrón (1/8 de barra, 40 gr.)									
107. Mantecados, mazapán (90 gr.)									

CONSUMO MEDIO DURANTE EL AÑO PASADO

	NUNCA O CASI NUNCA	AL MES	A LA SEMANA			AL DÍA			
		1 - 3	1	2 - 4	5 - 6	1	2 - 3	4 - 6	6 +
VIII. MISCELÁNEA									
108. Croquetas, buñuelos, empanadillas, precocinados (una)									
109. Sopas y cremas de sobre (1 plato)									
110. Mostaza (una cucharadita de postre)									
111. Mayonesa comercial (1 cucharada sopera = 20 gr.)									
112. Salsa de tomate frito, ketchup (1 cucharadita)									
113. Picante: tabasco, pimienta, pimentón (una pizca)									
114. Sal (una pizca)									
115. Mermeladas (1 cucharadita)									
116. Azúcar (1 cucharadita)									
117. Miel (1 cucharadita)									
118. Snacks distintos de patatas fritas: gusanitos, palomitas, maíz, etc. (1 bolsa, 50 gr.)									
119. Otros alimentos de frecuente consumo:									
119.1									
119.2									
119.3									

SUMICO 12637-03-2

Por favor, marque una única opción para cada alimento.

IX. BEBIDAS

	CONSUMO MEDIO DURANTE EL AÑO PASADO								
	NUNCA O CASI NUNCA	AL MES	A LA SEMANA			AL DÍA			
		1 - 3	1	2 - 4	5 - 6	1	2 - 3	4 - 6	6 +
120. Bebidas carbonatadas con azúcar: bebidas con cola, limonadas, tónicas, etc. (1 botellín, 200 cc)									
121. Bebidas carbonatadas bajas en calorías, bebidas light (1 botellín, 200 cc)									
122. Zumo de naranja natural (1 vaso, 200 cc)									
123. Zumos naturales de otras frutas (1 vaso, 200 cc)									
124. Zumos de frutas en botella o enlatados (200 cc)									
125. Café descafeinado (1 taza, 50 cc)									
126. Café (1 taza, 50 cc)									
127. Té (1 taza, 50 cc)									
128. Mosto (100 cc)									
129. Vaso de vino rosado (100 cc)									
130. Vaso de vino moscatel (50 cc)									
131. Vaso de vino tinto joven, del año (100 cc)									
132. Vaso de vino tinto añejo (100 cc)									
133. Vaso de vino blanco (100 cc)									
134. Vaso de cava (100 cc)									
135. Cerveza (1 jarra, 330 cc)									
136. Licores, anís o anisetes... (1 copa, 50 cc)									
137. Destilados: whisky, vodka, ginebra, coñac (1 copa, 50 cc)									

138. ¿A que edad empezó a beber alcohol (vino, cerveza o licores), incluyendo el que toma con las comidas con regularidad (más de siete "bebidas" a la semana)?

Edad (años)

Decena: 0 1 2 3 4 5 6 7 8 9

Unidad: 0 1 2 3 4 5 6 7 8 9

139. ¿Cuántos años ha bebido alcohol con regularidad (más de siete "bebidas" a la semana)?

Años

Decena: 0 1 2 3 4 5 6 7 8 9

Unidad: 0 1 2 3 4 5 6 7 8 9

119. Otros alimentos de frecuente consumo

119.1 (No marque aquí)

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

119.2 (No marque aquí)

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

119.3 (No marque aquí)

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

Si durante el año pasado tomó vitaminas y/o minerales (incluyendo calcio) o productos dietéticos especiales (salvado, aceite de onagra, leche con ácidos grasos omega-3, flavonoides, etc.), por favor indique la marca y la frecuencia con que los tomó:

Marcas de los suplementos de vitaminas o minerales o de los productos dietéticos	CONSUMO MEDIO DURANTE EL AÑO PASADO								
	NUNCA O CASI NUNCA	AL MES	A LA SEMANA			AL DÍA			
		1 - 3	1	2 - 4	5 - 6	1	2 - 3	4 - 6	6 +
140.									
140.1									
140.2									

140 (No marque aquí)

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

140.1 (No marque aquí)

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

140.2 (No marque aquí)

0 1 2 3 4 5 6 7 8 9

0 1 2 3 4 5 6 7 8 9

SUMCO 12637-03-(Ret.2)

Muchas gracias por su colaboración

FACULDADE DE MOTRICIDADE HUMANA
Universidade Técnica de Lisboa

Laboratório de Exercício e Saúde

CONSENTIMENTO INFORMADO

1. No âmbito de um estudo a realizar com atletas, foi solicitada a participação do meu educando num trabalho de investigação, a decorrer na Faculdade de Motricidade Humana.
2. Este estudo permitir-me-á aceder ao perfil de composição corporal do meu educando possibilitando uma estimação dos níveis de peso corporal óptimos para atletas.
3. A participação irá incluir a avaliação da composição corporal através dos métodos mais recentes e precisos que fazem parte do Laboratório de Exercício e Saúde da Faculdade de Motricidade Humana.
4. Eu entendo que os resultados deste estudo possam ser publicados, mas o nome ou identidade do meu educando não serão revelados. No sentido de manter a confidencialidade dos seus registos (testes), o laboratório irá utilizar códigos para os nomes, que serão protegidos pelo acesso individualizado à base de dados resultante.
5. Quaisquer questões que eu tenha, em relação ao estudo ou à participação do meu educando, serão respondidas pelo técnico responsável, antes ou depois do meu consentimento.
6. Fui informado de que não serei compensado monetariamente pela participação do meu educando neste estudo.
7. Eu percebo que, em caso de lesão, se tiver alguma questão acerca dos direitos do meu educando como participante neste estudo, ou se sentir que ele foi colocado em risco, posso contactar o director responsável pelo laboratório.
8. Eu li toda a informação supracitada. A natureza, exigência, riscos e benefícios do estudo foram-me explicados. Eu assumo os riscos envolvidos e entendo que posso retirar o meu consentimento e parar a participação do meu educando em qualquer momento, sem qualquer prejuízo para ele. Ao assinar este formulário de consentimento, eu não estou a renunciar a quaisquer direitos legais, reclamações ou remédios. Uma cópia deste formulário ser-me-á fornecida.

Assinatura _____ Data: _____

9. Eu certifico que expliquei ao encarregado de educação supracitado a natureza, objectivo, potenciais benefícios e possíveis riscos associados à participação neste estudo, respondi a todas as questões que me foram colocadas e testemunhei a assinatura acima realizada.
10. Eu providenciei uma cópia deste formulário ao encarregado de educação do atleta participante no estudo.

Assinatura _____ Data: _____
(O Director do Laboratório de Exercício e Saúde)